Of this issue more than 4000 copies were printed

The Welding Engineer

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ADVERTISING is a factor of constantly increasing power in modern business. The agencies for the dissemination of information have increased remarkably. The use of advertising from sporadic efforts has developed into sustained and carefully directed campaigns.

The man who advertises to reach the welding trade and who has not investigated The Welding Engineer is guilty of sporadic advertising—he has not made a careful analysis of the potential purchasing power of the readers of The Welding Engineer.

The Welding Engineer presents no problem of waste circulation or lost motion. It is read by those who are interested in welding subjects. You pay for readers of that type—and you get them.

Send for the report of the Audit Bureau of Circulations covering the circulation of The Welding Engineer.

L. B. Mackenzie

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The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

Oxweld Equipment includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship, **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

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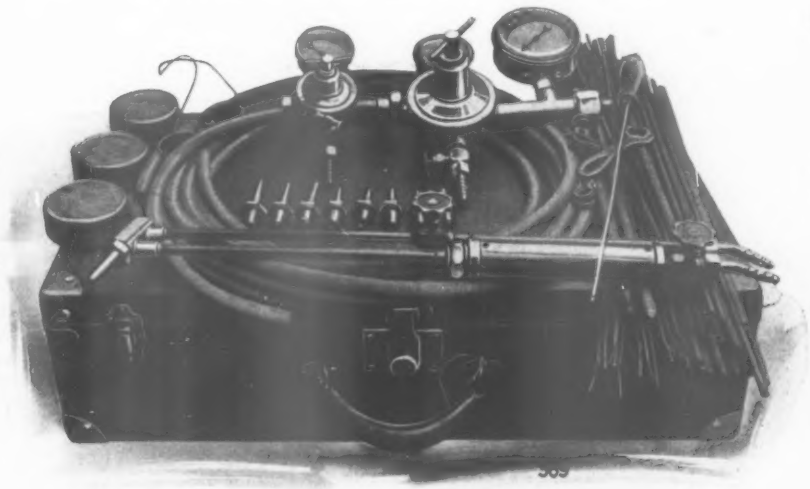

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The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

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Superior Oxy-Acetylene Machine Co.
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Vulcan Press Co.
Welding Materials.

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Vulcan Process Co.
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Superior Oxy-Acetylene Machine Co.
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Vulcan Process Co.
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Buffalo Dental Mfg. Co.

BOOKS (Relating to Welding)
The Welding Engineer

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Henderson-Willis Welding & Cutting Co.
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Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

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Universal Oxygen Co.
Vulcan Process Co.

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The Turner Brass Co.

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Universal Oxygen Co.
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Canada Carbide Sales Co.
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Henderson-Willis Welding & Cutting Co.
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Universal Oxygen Co.
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FILLER RODS (Cast Iron). See "Cast Iron"

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Universal Oxygen Co.
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FLUX WELDERS (Electric)
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The succeeding years have been devoted to introducing to the iron and steel industry and metal workers this process of welding all metals and of cutting steel, with constant effort to provide not only the most efficient apparatus, but also the widest range of equipment and the best obtainable supplies for all uses of the oxy-acetylene flame, and to extending its application by co-operation with metal workers, foundries and steel mills, through efficient demonstration, development and instruction service.

As a result, there is more Davis-Bournonville welding and cutting apparatus in successful use in the United States than of any other make, and the prominent concerns which have established the greatest success with this process have large installations of D-B apparatus, with from ten to one hundred torch units, and two, three and four of the largest acetylene generators.

The increasing use of Davis-Bournonville apparatus, as indicated by sales, is graphically shown in the above diagram. The fifth year's output of apparatus was *twenty times greater* than the first year's. Last year's output was *fifty times greater* than the first year's, and already this year (three months only) gives indication of a proportionate increase in the number of users of Davis-Bournonville apparatus.

Write for bulletins and information showing why Davis-Bournonville apparatus is employed by the largest steel mills, foundries, shipyards, locomotive and car builders, mines, sheet metal working factories, gas companies, tube manufacturers, scrap yards, and hundreds of small repair shops and garages.

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Universal Oxygen Co.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

FLUX (Brass and Bronze). See "Flux"

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The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
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GAS BURNERS (Preheating)
Campbell & Rickel.
The Macleod Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.
The Turner Brass Works.

GENERATORS (Acetylene)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
International Oxygen Co.
The Macleod Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

GLOVES (Asbestos)
Welding Materials.

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Bermo Welding Apparatus Co.
Campbell & Rickel.
Chicago Eye Shield Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Turner Brass Works.
Universal Oxygen Co.
Vulcan Process Co.
Westinghouse Electric & Mfg. Co.
Welding Materials.

GLOVES (Welders Asbestos)
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Oxweld Acetylene Co.
Universal Oxygen Co.

GAUGES (Pressure)
Bermo Welding Apparatus Co.
Campbell & Rickel.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
U. S. Gauge Co.
Vulcan Process Co.

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Henderson-Willis Welding & Cutting Co.
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Superior Oxy-Acetylene Machine Co.
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Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.

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Campbell & Rickel.
Davis-Bournonville Co.
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International Oxygen Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
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SPELTER WIRE (Brass)

SPOT WELDERS (Electric Resistance)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
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The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
The Turner Brass Works.
Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.
Vulcan Process Co.

VALVES (Acetylene Regulating)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
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Universal Oxygen Co.
Vulcan Process Co.

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The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

VALVES (For Oxygen Cylinders)
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Universal Oxygen Co.

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The Imperial Brass Mfg. Co.
International Oxygen Co.
Universal Oxygen Co.

VALVES (Oxygen Regulating)
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Davis-Bournonville Co.
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Universal Oxygen Co.
Vulcan Process Co.

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Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.
Welding Materials.

WELDING MACHINES (Electric)
See Arc, Butt, Seam Welders.

WELDING (Oxygen for)
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The Linde Air Products Co.
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Bermo Welding Apparatus Co.
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Davis-Bournonville Co.
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The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Macleod Co.
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The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co
The Turner Brass Works.
Universal Oxygen Co.
Vulcan Process Co.

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Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Campbell & Rickel.
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Linde Oxygen, made by the liquid-air process, is of the highest purity and efficiency. Exacting users demand Linde Oxygen, knowing they can obtain a uniformly pure gas, from a convenient source of supply, whether their requirements are large or small or vary from day to day.

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Linde Oxygen is furnished in steel cylinders containing 100 and 200 cu. ft. respectively.

A large supply of charged cylinders is kept constantly on hand at all Distributing Stations, ready for immediate shipment.

LINDE SERVICE means no investment except for Oxygen actually received—no expensive overhead, or upkeep charges.

Linde Oxygen may be obtained direct from any of our Distributing Stations. Mail or 'phone your order to THE LINDE AIR PRODUCTS CO., at any of the following points:

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113 Austin Avenue
CINCINNATI, OHIO
63 Plum Street
CLEVELAND, OHIO
E. 73rd St. and Bittern Ave.
COLUMBUS, OHIO
310 Dublin Avenue
DAVENPORT, IOWA
118 Harrison Street
DAYTON, OHIO
521-523 E. First Street
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16th and Glenarm Sts.
DETROIT, MICH.
St. Aubins Avenue
DULUTH, MINN.
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EAST ST. LOUIS, ILL.
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LARGEST PRODUCERS OF OXYGEN IN THE WORLD.

Other Plants and Warehouses are planned for other industrial centers throughout the country and will be established as fast as and wherever the local demand for oxygen warrants.

No. 8-G Blowpipe
For Natural Gas, $4.25

The Two Most Essential Points in Welding *ARE*

FIRST: The use of a proper sized oxy-acetylene flame.

SECOND: The saving of gas by preheating your work for the oxy-acetylene flame.

The first is under your control in the use of the oxy-acetylene apparatus you have selected.

The second we can aid you in by supplying the proper blowpipes for preheating purposes.

Over forty years' experience in the manufacture of this article has enabled us to produce a series of blowpipes that will give you the maximum amount of heat with the minimum consumption of gas.

It is not practical or economical to use a blowpipe larger than our No. 8-G—for natural gas, or No. 8-F—for coal gas. If you have a piece of work requiring more heat than a single blowpipe of this size will give you, use two or more blowpipes of this size.

Our catalog "BX"—free for the asking—contains full description of all our blowpipes. WANT ONE? WHAT'S YOUR ADDRESS?

BUFFALO DENTAL MANUFACTURING CO.
BUFFALO, N. Y., U. S. A.
Blowpipes for Coal Gas, Natural Gas, Gasoline Gas and Acetylene Gas and Air Blast

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American outfits are made to make good. They are carefully designed and made from the very best materials, with but one object in view—to secure the very highest commercial efficiency.

American torches are constructed for constant heavy service and are free from back-firing and danger to the operator. The needle valves are conveniently located, which permits the operator to adjust flame with torch hand and without laying aside welding stick.

Write for our descriptive circular. It's full of good information.

American Welding Co., Inc.
2724 Michigan Ave. Chicago, Ill.

U. S. Gauge Company

New York

The DAVIS - BOURNONVILLE COMPANY has adopted the U. S. GAUGE as standard on their equipment. Its record in service, together with distinctive patented safety features commend it to the best trade.

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Montreal, Board of Trade.

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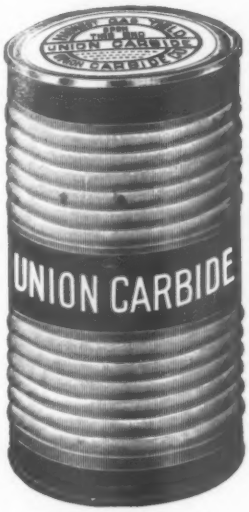

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UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

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Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.
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Denver—Nineteenth and Wazee Sts.
Victor—Third and Diamond Sts.
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Hartford—877 Main St.
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Washington—Maryland Ave. and 9th St., S. W.
FLORIDA
Jacksonville—106 E. Forsyth St.
Tampa—418 Tampa St.
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Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.
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Chicago—Peoples Gas Bldg., Michigan Blvd.
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Marion—315 S. Granite St., Box 747.
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Quincy—222 S. Eighth St.
Streator—702 East Elm St.
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Evansville—1601 Illinois St.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.
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Des Moines—117-119 Fifth St.
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Pittsburg—109 W. Third St.
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Wichita—721 Beacon Building.
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Louisville—126 E. Main St.
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New Orleans—715-717 Perdido St.
MAINE
Portland—202 Commercial St.
MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
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Boston—(See Cambridge "A.")
Cambridge "A"—Waverly St. and Putnam Ave.
Springfield—Napier St.
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Detroit—Jefferson Ave. and Orleans St.
Grand Rapids—135 Ottawa Ave., N. Y.
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Jackson—172 South Water St.
Saginaw—1902 N. Michigan Ave.
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MINNESOTA
Minneapolis—334 N. First St.
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MISSISSIPPI
Vicksburg—1312 Washington St.
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Kansas City—1316-1318 W. Eighth St.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)
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Omaha—1007-9-11 Jones St., Union Sta. P. O.
NEW HAMPSHIRE
Concord—77 South Main St.
NEW JERSEY
Camden—Delaware Ave. and Cooper St.
Jersey City—554-56 Henderson St.
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We recommend our customers to **select** from the list, the **city** from which the quickest delivery and lowest freight rate can be obtained, **and address their orders to "Union Carbide Sales Company"** at the distributing point selected **accompanied by remittance.**

Please address request for information or special correspondence to either the Chicago or New York office.

Better Welding

results are certain when your Acetylene gas is made from chemically pure carbide, because the heat is more intense when the acetylene is pure.

Carbolite

is a very superior quality of Calcium Carbide—made from the purest raw materials we can buy—in fact it is chemically pure carbide, guaranteed to produce the highest average gas yield.

Packed in drums containing 100 lbs. net.

Warehouses in all principal cities.

Write for Quotations and further Information

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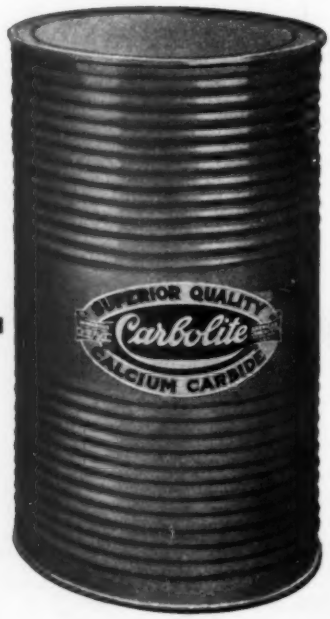
Duluth, Minn.



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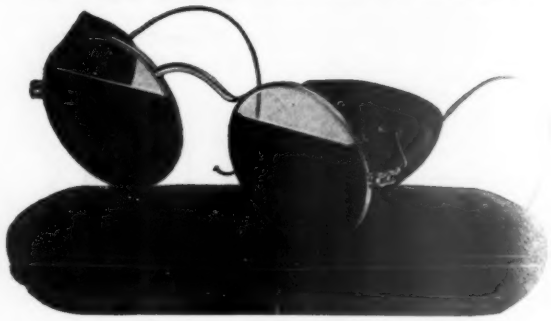

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Solid white metal frames, easy cable temples, leather sides and adjustable bridges.

Upper part, clear glass; lower part, gray green Hallauer glass for welding.

Per pair - - - - - - - - - - - - $1.50

Blue-White

Same frame with the upper part, cobalt blue glass; lower part, clear glass.

Each pair supplied with a strong steel case.

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A large stock of **torches, regulators, gauges, reducing-valves, copper wire bound high pressure hose** and **plain black rubber gas hose,** and all extra accessories and supplies for this line of work, is in our shops, New York City, at your demand.

The K-G Apparatus is accepted by those who know as the best money can buy. It is built to stand up.

This is not merely a statement of our opinion, but is proven by their universal adoption and long continued use.

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Universal

UNIVERSAL OXYGEN COMPANY
SHEBOYGAN, WISCONSIN, U.S.A.

PURE OXYGEN and HYDROGEN GASES
WELDING and CUTTING EQUIPMENT
Milwaukee Branch: 315 Fourth Street

Figure the Costs Yourself, with

I.O.C. SYSTEM OXYGEN and HYDROGEN GENERATORS

Either our Unit or our Bipolar Generator produces 4 cu. ft. of oxygen and 8 cu. ft. of hydrogen per kilowatt hour. Knowing your current cost, figure for yourself the power cost per cu. ft. of gas. The added cost factors—interest, depreciation, up-keep, attendance (the latter practically nothing)—will increase this slightly. But you will still find that your own I. O. C. plant will save you 50 to 60 per cent over the cost of gas in cylinders. Why—then—persist in wasteful methods? Let us consult with you.

I. O. C. Single Unit Generator

Send for our new Catalog No. 3, describing the latest types of I. O. C. Gas Generators.

INTERNATIONAL OXYGEN COMPANY
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Welding Plants for All Purposes

12 Sizes—Ranging in price from
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A "BERMO" Plant means more profit for you.

Shipment made same day order received.
Liberal terms on plants if desired.

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The "CHICAGO" Welder's Safety Goggles

For Gas Cutting or Welding
For Electric Welding Apparatus
For Arc Welding Apparatus

No. 380—Price $1.00

Ventilated Sides
Heavy Elastic
Leather Nosepiece

Ask your jobber for either of these. He can supply you.

Lenses of any color or shade desired.

No. 500—Price $1.50
Fibre Frame an Absolute Non-Conductor of Heat

Manufactured by CHICAGO EYE-SHIELD CO., 134 So. Clinton St., CHICAGO, ILL.

WILLIS OXY-ACETYLENE APPARATUS WELDERS

"WILLIS" PRESSURE GENERATORS

"Willis" Pressure Generators are made in sizes of 50 pounds, 100 pounds, 200 pounds and 300 pounds capacity of carbide per charge.

The generator of 50 pounds capacity is standard for repair shops and light manufacturers, while the larger sizes provide an ample supply of gas for more extensive use.

The "Willis" Pressure Generators stand alone. The theoretical engineer and the practical welder proclaim their superiority. One of the important features to be considered in an acetylene generator is

Safety. We have made **safety** the first consideration, and how well we have succeeded is attested by the fact that we have never had an accident or explosion occur to any of our apparatus—a record held only by this Company. Our apparatus is as near "fool-proof" as it is possible for mechanical appliances to be.

The "Willis" Generators have independent power for feeding lump carbide and automatically starts and stops according to the pressure of the gas. These generators require no attention after being filled with carbide.

THE WELDING TORCH

Of equal importance to the Acetylene Generator is the welding torch itself. The "Willis" torch knows no equal. It is of the medium pressure type, and is known as the Constant Neutral Torch. The mixture of the gases is obtained in the head, and interchangeable tips of different capacity are provided to regulate the size of the flame.

Heads having different angles are furnished and are also interchangeable. This is a special patented feature of our torch and is found to be of great assistance to the operator. For ordinary bench work a torch having a head at about a 90 degree angle is most desired, while for boiler welding such as side, flue, or crown sheet work, a much greater angle than 90 degrees is preferable. These heads of different angles all fit the same torch. Another advantage which the "Willis" torches possess is that the heads rotate on the torch proper and are easily and quickly turned to any angle in the arc. For overhead work and certain other classes, this is of great assistance. These features give the torch pre-eminence as to facility. We guarantee our torch to procure as low a ratio of oxygen to acetylene as it is possible to obtain and maintain a neutral flame.

THE CUTTING TORCH

The Welding Torch can be easily and quickly transformed into a Cutting Torch by simply removing the Welding head and replacing same with the cutting attachment. This attachment connects with the oxygen supply for welding and only one oxygen hose is required. With this cutting torch it is possible to cut in any direction, as the oxygen jet always impinges on hot metal.

MANUFACTURED BY

The Henderson-Willis Welding and Cutting Co.

GENERAL OFFICE AND FACTORY

ST. LOUIS, MO., U. S. A.

Swift Oxygen

For Welding and Cutting

Unsurpassed for Quality

Pure Oxygen Electrolytically Made under the direct supervision of our Chemical Laboratory. It is carefully controlled by chemical analysis, thus insuring the highest obtainable purity.

We carry a large stock on hand so can fill orders immediately.

Swift & Company

Oxygen Department **Union Stock Yards, Chicago, Ill.**

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30 Church Street
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CANADIAN CARBIDE

"More gas per pound"

SIZE PKGS.
100 lb. and 1,000 lb. 25-lb. drums; 10 lb., 5 lb., 2 lb., 1 lb. tins

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Salt Lake City—121 W. 2nd South St.
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Richmond—1319 E. Main St.
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Charleston—821 Virginia St.

For special information address correspondence to New York City.

No. 5 A Turner Complete Welding and Cutting Outfit

Another Step In Advance

This new torch places Turner equipment another step in the lead. Turner Outfits have always set the pace in the development of oxy-acetylene equipment since entering the field, the Turner Company being the first to produce an adjustable Torch—one that met the requirements of all shops and factories. With this torch it is possible to do any class of work, from the welding of spectacle frames up to castings weighing tons. The one torch can be adjusted to many different sizes and shapes, or in other words, allowing the operator to adjust the torch to any job, small or large.

CONTENTS.

1 No. 137 **"Nev-o-fail"** Combination Welding and Cutting Torch with sectional lengths.
9 Welding Tips, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9.
3 Cutting Heads, 5A, 5B, 5C.
2 15-ft. lengths Best Hose.
1 Turner Oxygen Regulator.
1 Carbon Burner No. 201.
1 Turner Acetylene Regulator.
1 Adjustable Wrench.
1 Pair Goggles.
3 Bundles Refined Cast Iron Welding Rods.
1 Bundle Steel Welding Rods.
1 Bundle Tobin Bronze Welding Rods.
1 Bundle Aluminum Welding Rods.
1 Box "Turner" Cast Iron Welding Flux.
1 Book of Instructions.
1 Case.
1 Wrench for Cutting Torch.
Net Weight 55 Pounds.
Shipping Weight 75 Pounds.

The latest improvement is the Combination Welding and Cutting Torch. This Torch will do work that would require at least five different Torches of other makes to accomplish, and even more, as it will do work that no other standard Torch will do. It would require the building of special Torches to compete with it.

No. 135 "Nev-o-fail" Cutting and Welding Torch

REASONS WHY TURNER OUTFITS ARE SUPERIOR.

1—Torch is adjustable to any work.
2—The valves are located so that they can be manipulated with the hand grasping the handle, requiring the use of only one hand to operate it and allowing instant control.
3—The mixing chamber is remote from the heat, insuring no flash backs from over heating.
4—The light weight of the Torch.
5—The cutting head is cast in block, having no tips, therefore having no inside joints to leak and cause the Torch to flash back or get out of working order.
6—There are no small parts or cutting tips to get lost or out of order.
7—The construction is very simple, making it easy to operate and more efficient.

These features were all originated by the inventor of the Turner equipment and are fully covered by patents. All other imitations are infringements.

Write for Catalog

The Turner Brass Works

Manufacturers of Automobile Specialties, Blow Torches and Fire Pots

Sycamore, Illinois -:- U. S. A.

Complete
Oxy-Acetylene
Welding and
Carbon-burning
Apparatus

$55.00

Write for Announcement "W" and Price List on Welding Supplies

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6300°

OXY-ACETYLENE WELDING AND CUTTING APPARATUS

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THERMALENE — THE GAS OF GREATEST EFFICIENCY — THERMALENE

The Oxy-Thermalene Method
of Welding, Cutting, Brazing, Etc.

The only Acetylene Oil Gas generator in the world. Saves 25% on gas and oxygen. First class references. We also sell complete Oxy-Acetylene equipment for dissolved Acetylene for $42.00.

Thermalene gas in conjunction with Oxygen gas produces the ideal flame for welding and cutting. There is no loss of time due to shortage of gas. The generator works only when you work. When shut off, generator ceases instantly.

Thermaline will not produce faulty welds due to impure and moist gas. The generator may be mounted on a truck and made portable.

Thermaline Gas, being heavier and richer than Acetylene and other gases, has more body, producing a softer non-oxidizing flame, which assures a more uniform weld and a cleaner cut, without burning or making the metal brittle.

Write for full information, catalog and prices.

THE THERMALENE COMPANY
Chicago Heights, Ill.

THERMALENE — THE GAS OF GREATEST EFFICIENCY — THERMALENE

Manufacturer's Service

We Furnish an experienced operator to teach the welding of High Speed and Tool Steel Machine Tools to your employes in your own shop.

We Furnish experienced operators for your plant. We have the records of over a hundred, and can supply you with the best for your line.

We Furnish Engineering Data to our customers that you cannot even buy elsewhere. There are ten methods of welding. We use and sell all. A postal brings you our service.

Welding Materials
Room 720, 115 S. Dearborn St., Chicago
Gas Chemical Electric

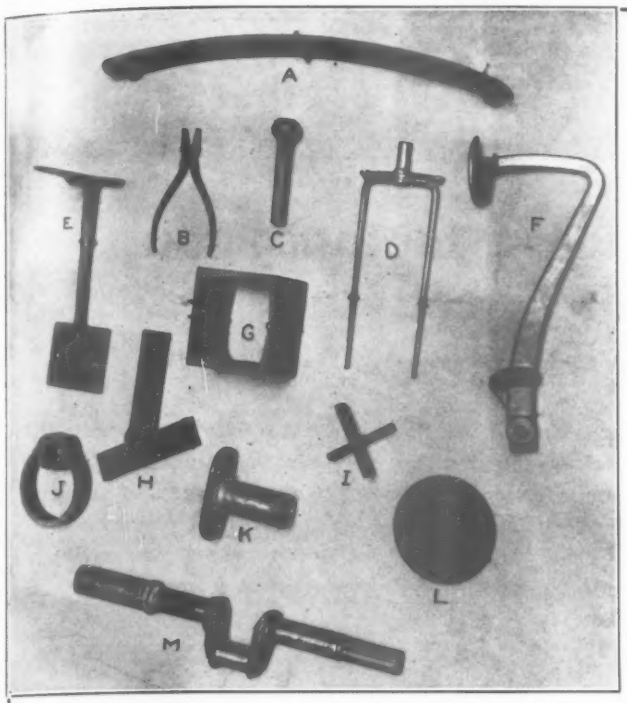
REMOVAL NOTICE

To provide adequate quarters The Welding Engineer has removed to the Transportation Bldg., Harrison and Dearborn Sts., 608 S. Dearborn St. The telephone number remains the same.

WANTED—BACK ISSUES

The Welding Engineer is in receipt of many requests for the January, February and March numbers. Unfortunately our reserve supply is entirely exhausted. For the return of every copy of either of the above issues we will be glad to extend subscriptions three months for every copy returned. Our honest advice, however, is to buy a binder and keep your file intact.

L. B. MACKENZIE.
608 S. Dearborn St., Chicago.



A—Spring for Auto.
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E—Auto step forging.
F—Auto foot brake.
G—Steel frame.
H—Oblique weld-steel flats.
I—Mash welded cross rods.
J—Magnet part.
K—Pipe welded to flange.
L—Solid round welded to forged flange.
M—End welded on single throw crank shaft.

THE "THOMSON" ELECTRIC WELDERS

There is hardly a metal working establishment in which electric welding machines can not be employed to very good advantage.

Manufacturers are cutting down costs by the use of Thomson Electric Welding Machines, and at the same time increasing and improving output.

Put your welding problems up to the

"PIONEER"

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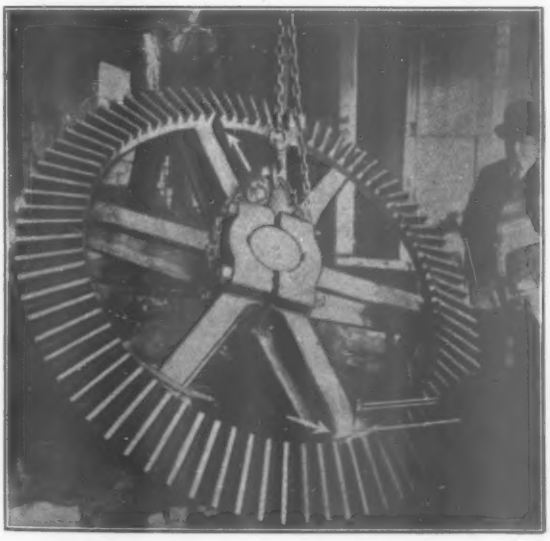

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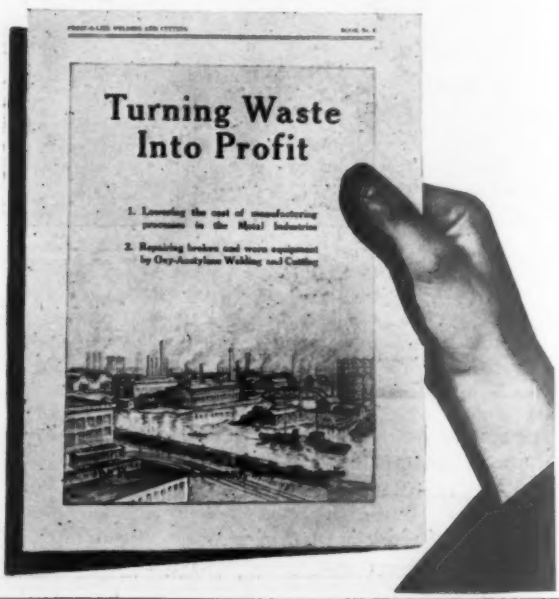

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VOLUME I. APRIL, 1916. NUMBER 4

The World's Supply of Metals

THE world has of late years used about 3½ million tons of the finer industrial metals, copper, tin, spelter, etc., in addition to the 60 to 80 million tons of iron annually consumed. A study of the production and consumption of these shows them moving steadily from countries of surplus production to countries of import because of short production, so steadily that the "visible supplies" on open markets are never, on the average, sufficient for more than a week. Of course, there are private stocks, and perhaps some hidden stocks, at times, furnishing much available metal, unused. But commerce does not normally keep large stocks ahead. And no one nation appears to be absolutely independent of the rest of the commercial world. In 1912 the world used over a million tons of new copper, of which we produced 547,000 tons and consumed 345,000. Germany produced 25,220 tons and consumed 243,173. English possessions produced 47,020 tons and consumed 147,551. France consumed 106,753 tons. Of tin, 116,079 tons appeared in 1913. The United States took 45,551 tons. The world produced 1,186,700 tons of pig lead in 1913; 407,800 tons in the United States, 181,100 in Germany, 203,000 in Spain, 163,000 in British possessions. The consumption of lead was placed at 1,196,200 tons; 401,300 by the United States; 223,500 by Germany; 191,400 by England; 107,600 by France. The world produced 1,093,635 short tons of spelter in 1913; 346,676 in the United States, 312,075 in Germany, 70,000 by England's possessions. We consumed 295,270 tons.

The United States produces more copper, iron, zinc and lead than any other country. It buys nearly all the tin it consumes, taking 92 per cent of its imports from England or its dependencies. It could produce more tin, and more nickel, and much more tungsten than it does. There are available sources of many other raw products which, in the free commerce of the world as heretofore organized, it could better afford to import. The economies of buying our "fine" chemicals from Germany have likewise rendered temporarily unnecessary the growth of a chemical industry here, just as they have in England. The question now is whether world-relations have so changed as to make it a matter of national economic policy to find some best way of developing resources that do not naturally pay, and of building up the industrial gaps where the "key" materials are produced.

Right now the business of this country appears to be on the point of learning a lesson about the economies of the conformation of interlocking industry. Various kinds of manufacture are at the moment greatly hindered and made much more costly by the shortage of materials not only included among those that we have heretofore normally imported but of some that we have always made in sufficient quantity for domestic use and are now preferring to sell abroad for high prices, at the sacrifice of the interests of our own industries. We have paper and printing establishments doing a business of over a billion; drugs and paints making that total nearly half a billion; leather works and collaterals whose output is just above a billion; iron and metal trades producing upwards of five billions; a textile industry directly producing over $3,000,000,000 worth; and then a considerable aggregation of miscellaneous collateral industry, besides much trade directly dependent upon the health of these. The stream of materials that, being the finished products of one, become the raw stuffs entering vitally into another, are the life-blood of the body industrial and commercial.

The Tungsten Question

ONE thinks of electric lights when tungsten is mentioned, but we could probably do much easier without tungsten lamps than we could without tungsten steel. If we could not obtain any tungsten in this country, the effect upon our whole steel industry would be exactly the same as if some 40 per cent of the machinery in factories filled with lathes, drills, planers, etc., were scrapped over night. Tungsten is the necessary element in "high speed" steel tools. There are several other rarer metals with the same properties, but they hardly count, in practice. America gave the world "high-speed" steel, the tungsten-steel which retains its temper and edge even when it becomes red-hot through rapid cutting into the carbon-steel which it is machining. By means of it a lathe and a workman can together do twice the work of old times with the hardest tools of ordinary metal. But England has at present the control of the available supply outside the Teutonic countries. It is significant of the state of affairs which the war has uncovered, that while Burma is the leading producer of tungsten ore, English commercial leaders are saying that German interests had gained the control of this production in English territory and that large supplies had been diverted to Austrian laboratories where the processes of getting commercial tungsten are carried on. However, men who are consumers of tungsten here speak of England as the principel ante-bellum source of our supply. There is quite a large amount of tungsten mined and metalicized in this country, but evidently outside hands held direction over the markets here. It is a very important material: It is running short even in England now, and Sheffield workmen are searched for it when they leave their machines after the day's work. Tungsten steel is going high in price. In this country, at this minute, there is a shortage of tungsten, and this is considerably increasing the cost of production in our metal-working shops. "High-speed" steel tools are costly, though not yet unobtainable, and the effect of going back to carbon-steel is to slow down machinery, to increase perceptibly the "overhead" in factories because the time and speed of machinery is measured in cost of the capital that bought it, and to raise directly the cost of labor because a workman produces less.

Thermit and Its Practical Applications

The Thermit Process Differs Essentially from All Other Systems—An Interesting Story of the Process Discovered and Perfected by the Famous Chemist, Dr. Hans Goldschmidt

By W. B. Hulburt*

The Thermit Process as applied to all welding except pipe welding is generally classed as an autogenous process. There is some difference of opinion, however, as to whether Thermit welding can properly be called autogenous or not, as that term is generally applied to oxy-acetylene welding. In the opinion of the writer the term autogenous is a misnomer as, strictly speaking, autogenous means either self welding or welding with the same metals, whereas two different metals are sometimes united with a third metal and the result is not comparable with brazing or soldering, as there is a more intimate molecular union. As a matter of fact, Thermit welding is really a form of cast welding, as the union is made by the flowing together of the metals. This also, of course, applies to oxy-acetylene welding, but with that process the metal is added drop by drop, while in the case of Thermit welding, the metal to make the weld is supplied in a considerable quantity at one time. The Thermit process also differs materially from all of the so-called autogenous processes, in the fact that it supplies its own heat and its own liquid metal. It is, therefore, adapted to an entirely different class of work, and so occupies a field entirely its own.

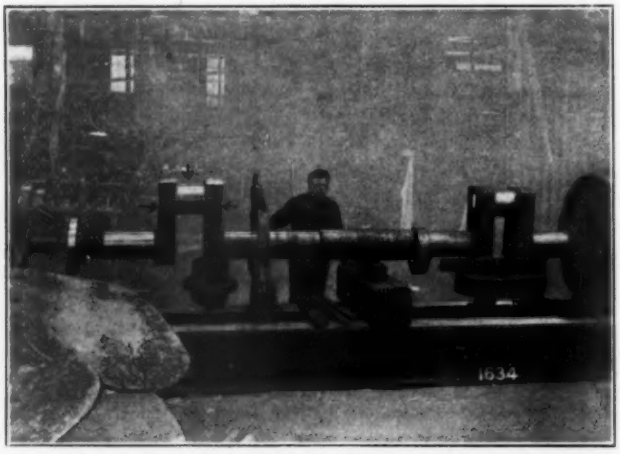


Fig. 1—The arrows indicate the location of the Thermit welds that have been machined. This cut shows 8½-inch crank shaft machined and ready for service.

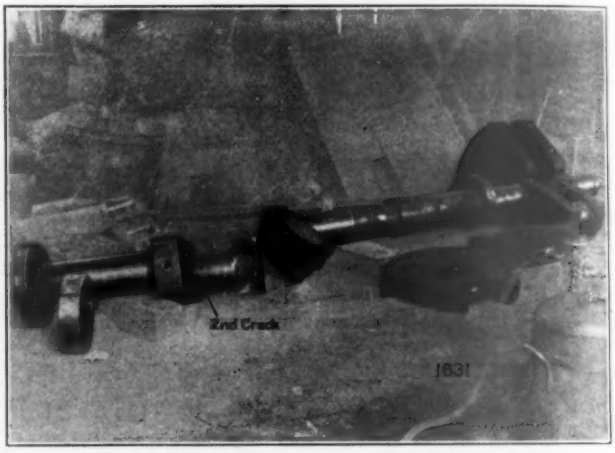


Fig. 3—8½-inch crank shaft broken off next to slab, and there is also another crack opposite the other slab.

Before describing the process in detail it is necessary to say a few words about aluminum, as that is the basis of the Thermit process. Aluminum, as is generally known, is the most widely distributed metallic element in the earth's crust, but the reason that it is a comparatively expensive metal as compared to iron and other of the more common metals is because wherever aluminum is found, it is always in combination with oxygen in one form or another, and it is only within comparatively recent years, that any commercial process has been perfected which will separate aluminum from oxygen and enable the metal to be produced at a cost to make it generally available.

Frederick Wehler, Professor of Chemistry at the University of Gottingen, succeeded in obtaining very small quantities of metallic aluminum about the year of 1827, but for eighteen years after that, the metal in any considerable quantity was really unknown, and it remained for a French chemist, H. St. Claire De Ville, to isolate aluminum into a state of almost perfect purity and determine its true properties. This was in 1854. At that time, however, only very small quantities were available. It remained for another French chemist, Heroult, and an American metallurgist, Hall, to really produce aluminum in large quantities at a reasonable price, and this was worked out simultaneously by Heroult in Europe and Hall in America, both using the electric furnace for reducing the aluminum ore. As a result of this, practically all aluminum produced abroad is made under the Heroult patents and in America under the Hall patents.

The fact that aluminum is hard to separate from oxygen is taken advantage of in the Thermit process, as it is possible to start a chemical reaction between the two when they are treated to a sufficiently high temperature. Chemists for many years since aluminum was discovered have known of this reaction and experimented with it in the reduction of different oxides, mixing finely divided aluminum with a metallic oxide, placing the mass in a crucible and then heating until the reaction took place. It was found that this resulted in a very violent reaction, practically an explosion, so that the reaction was of no commercial value. Dr. Hans Goldschmidt, a German chemist and metallurgist, discovered that this reaction could be controlled if instead of heating the entire mass, he simply heated the mass in the crucible at one spot. The reaction would then spread through the rest of the mixture and at the end of the reaction he would have aluminum oxide or slag floating on top in a molten state and the reduced metal at the bottom of the containing vessel. This discovery was the result of experiments by Dr. Goldschmidt, who was attempting to produce for the famous firm of Krupps, the steelmakers in Germany, pure metals to use as alloys with steel, and the first experiments were made with chromium oxide and finely divided aluminum. This reaction was entirely satisfactory, as the aluminum combined with the oxygen in the chromium oxide and pure chromium metal was reduced. He later experimented with other oxides, sulphides and chlorides and succeeded in producing pure manganese, ferro-chromium, molybdenum, ferro-titanium, and many other metals and alloys.

Among other oxides experimented with was iron oxide, but he found that this reaction not only produced a very pure, low carbon steel, but that the heat of this reaction was ex-

*Sales Manager, Goldschmidt Thermit Company, New York.

tremely high. No pyrometer will measure this temperature, but it has been worked out theoretically by Professor Richards of Lehigh University as approximately 4,881 degrees Fahrenheit. Dr. Goldschmidt decided that this intense heat, produced so quickly and easily, could be used in many ways for welding purposes, and the Thermit process which is now so widely known throughout the world is the result.

In making a Thermit weld, the parts to be united are first arranged with a space between them varying from one-half inch to two or three inches, depending upon the size of the sections. Where the pieces to be welded are in two parts, it is a simple matter, of course, to provide this space, but in the case of a fracture, it is often necessary to cut out the steel in order to provide the space needed, and this is done by drilling a line of holes along the fracture and then cutting out the metal between the holes or else the space is cut out by means of the oxy-acetylene cutting flame.

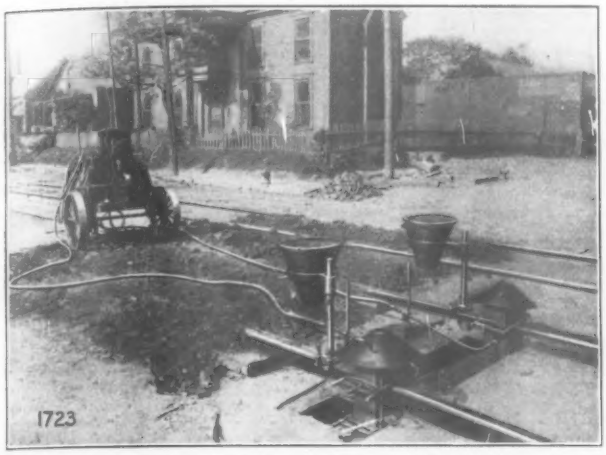


Fig. 5—Rail welding by the Thermit insert method. This shows preheating the molds previous to welding.

Fig. 6—Stern wheel shaft of steamship "Captain Weber." Welded with Thermit without removing it from the vessel.

In the case of welding locomotive frames, which is most important application of the process, it is almost always necessary to cut out the fracture. After the sections have been cut out, a wax pattern is formed around them of the exact shape of the reinforcement of Thermit steel, which is to be cast around them to make the weld. Thermit, as already explained, is a mixture of aluminum and iron oxide, which when ignited, reacts. The aluminum combines with the oxygen of the iron oxide while the iron is set free and comes down as a highly superheated liquid steel at a temperature of nearly 5,000 degrees Fahrenheit, or about twice the temperature of ordinary molten steel. It will be readily seen that if we pour this steel around the sections to be united, it will melt those sections and amalgamate with them so that the whole will cool down to form a single homogenous mass.

The wax pattern mentioned above is enclosed in a sand mold, wooden patterns being used for a pouring gate, a small preheating opening at the bottom and a large riser directly over the top of the weld. These wax patterns offer many advantages over the wooden patterns which are sometimes used, as they do away with the necessity of making the mold in two parts; in order to remove the pattern it is only necessary to apply the flame of a compressed air gasoline preheater to the heating opening and the wax is melted out, leaving the mold ready for pouring. For that part of the mold which comes in contact with the Thermit steel a mixture of one-third fire clay, one-third ground fire brick and one-third good sharp silica sand is used. This is mixed dry and then moistened just enough to tamp well. It is only used for the facing material and is backed up with a mixture of one-third fire clay and two-thirds sand. The mold, of course, is thoroughly vented in accordance with good foundry practice.

After the wax is melted out by the preheater, the heating is continued until the parts to be welded have been brought to a good red, workable heat. In the meantime the charge of Thermit is placed in a conical magnecite lined crucible suspended over the pouring gate of the mold and when the sections are red hot the preheater is withdrawn, the opening plugged up and the Thermit charge in the crucible ignited. In from 40 to 50 seconds the Thermit reaction is completed and the Thermit steel tapped from the bottom of the crucible into the mold where it flows around and between the sections to be welded together, uniting them into one solid

Fig. 2—New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.

Fig. 4—Large bevel gear on which two new teeth and crack have been repaired.

mass. The slag (aluminum oxide) does not enter the mold, but overflows it so that it does not interfere with the welding operation.

It will be seen that the process is a simple one and that the only outside power required to weld sections of any size is a small supply of compressed air for the operation of the preheater. The outfit is entirely portable and in many cases sections of very large size are welded without removal from their position, and therefore at the great saving in time and expense, over obtaining new parts or repairing by other means. This is particularly advantageous in the case of broken locomotive frames. It saves taking the frame out of the engine, welding it in a forge and replacing it. Furthermore, the process permits of fusing a collar or reinforcement of steel all around the welded part, thus increasing the cross-section at that point and making it stronger than it was originally.

In welding a locomotive frame it is necessary to jack the frame apart from one-eighth to three-sixteenths of an inch before putting on the mold in order to allow for the contraction of the Thermit steel when the metal in the weld cools. Where one part of a double barred frame is being welded this contraction is allowed for by heating up the other sections so as to expand it the required amount and holding that heat until the metal in the weld has solidified, after which the heat can be taken off and both sections will cool down and contract together. For such work a double

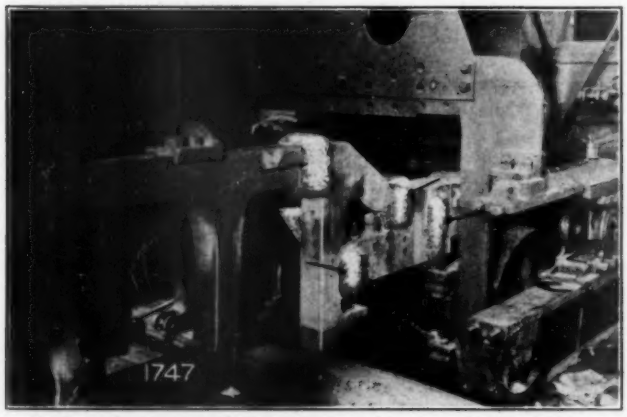


Fig. 7—Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.

burner preheater is necessary. One burner can be used to preheat the sections to be welded while the other can be directed into a small brick furnace erected around the second member in order to obtain the desired amount of expansion.

The great economy of the process in locomotive repair work has led to its adoption by practically all the railroads of consequence in the United States, Canada and Mexico, and the process is now used in 465 different railroad shops in North America.

Very little stripping of the engine is required for a Thermit weld, as it is only necessary to provide a clearance of about one foot all around the broken sections. In fact, it is usually only necessary to drop the driving wheels in order to effect a repair on a broken frame. Often the engine comes into the shop in the morning and twelve hours later the frame will be welded and the locomotive ready for service.

It is not only on locomotive frames, however, that Thermit finds extensive use in railroad shops, as it can be applied to equal advantage in the welding of broken driving wheel spokes, side rods, connecting rods, rocker shafts, cross head guides, cylinder saddles, mud rings and other broken sections too numerous to mention.

Aside from repairs in railroad shops, the process is used extensively in the marine field for welding broke[n] stern posts, rudder frames, and propeller struts of ste[am] ships. Here the process results in even greater economics [than] in the case of locomotive repairs, owing to the fact [that] dry dockage is exceedingly costly and every day saved [means] hundreds and even thousands of dollars. Such rep[airs] are usually executed by contract and seldom keep the v[essel] in dry dock more than forty-eight hours. The United [States] Navy has been one of the first to appreciate the adv[antage] of the process and has used it very extensively at the [Boston], New York, Norfolk, Portsmouth and Charleston Navy [Yards]. Furthermore, the repair ships "Panther," "Dixie," and "Vestal" are completely equipped with Thermit welding outfits and have done very important work.

On the Panama Canal the Government has used vast quantities of Thermit and employed the process for welding and reclaiming broken parts of dredges, dipper buckets, locomotives, rock crushers, rock drills, air compressors, and in fact, everything for which the process is adapted. Now that the great enterprise is practically completed, the process is still retained and will be used in the permanent repair shops for maintaining equipment used in operating the canal and for executing repairs on vessels passing through and utilizing the dry docks provided for that purpose.

In the way of general repairs, a great many crank shafts

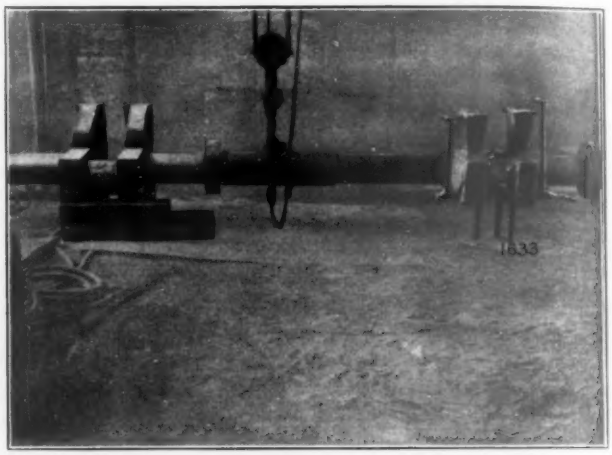


Fig. 8—An entire new pin and slab welded with Thermit before machining.

have been welded, particularly shafts for refrigerating machines. These shafts have to be aligned quite accurately before making the welds, and it has been found best to mount them on V-blocks supported on a machine bed plate as shown in the illustrations. The fracture is then cut out and the weld made in the usual way. In some cases it is necessary to cut out an entire bearing and weld in a block of steel to replace it with two Thermit welds, one on each end. The shaft can then be placed in a lathe and the bearing turned down to the proper size. It is usually impossible to keep these shafts in exact alignment during the welding operation, but they are seldom out more than 1/32-inch. This is readily corrected by taking a light cut off the bearings between the weld and one end of the shaft, considering the other part of the shaft to be true. While a great many of these shafts have been welded, none have so far failed. The reason for this appears to be that the shafts almost always break because of some flaw or defect in the material. This is often an old forging crack in the case of built up crank shafts, which gradually spreads until finally the shaft gives way. Of course, a shaft with such a flaw has no factor of safety at all, but if it were properly made, and all surplus metal machined off, the shaft will still have a factor of safety which is ample for all purposes and the owner will really have a better shaft than originally, because the flaw

has been located and eliminated and the rest of the shaft has been thoroughly tested.

Other repairs which are of particular interest comprise welds on large rolls and pinions in steel plants. In such cases it is usually necessary to cast on entire new ends and as this would prove rather costly with Thermit steel, a method has been devised which is just as effective and considerably less expensive. This method is now generally used by practically all the large steel mills in the Pittsburgh district.

The broken roll or pinion is placed vertically in a pit and a mold constructed around the fracture end. This end is then heated to a red heat by means of gasoline preheaters, after which it is covered with Thermit steel to a depth of one inch in order to bring it up to a fusing temperature. Liquid steel from a ladle is then poured into the mold and about 6,000 pounds allowed to run through and overflow. The overflow gate is then plugged up and the mold filled to the top. When the metal in the mold cools it will be found to have welded perfectly to the steel of the roll. The metal passing through the overflow gate is not wasted, but is caught in ingot molds and used in the regular way. It is not uncommon to repair rolls and pinions weighing up to 17 tons in this way.

Another important application of the Thermit is in the pipe welding. The method of doing this work is simple and novel, to say the least. Advantage is taken of the temperature of the slag and it is a fact that this slag will not stick to the pipe. On account of this, the mold for the purpose can be made of cast iron and surrounds the pipe ends, which are accurately butted together and held in place with clamps. The Thermit is ignited in a flat bottom crucible and at the end of the reaction the slag which floats on top of the Thermit steel is poured into the mold—the steel going in afterwards. The slag and steel combined serve to bring the pipe ends up to a welding temperature, at which time they are squeezed together by means of the clamps and a butt-weld effected. At the end of the operation the entire mass may be knocked away from the pipe and the only resulting effect will be a slight upset at the joint.

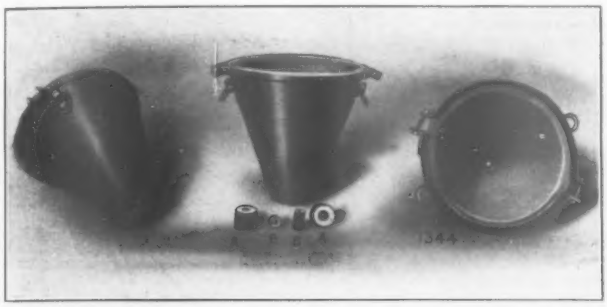


Fig. 9—Three views of a Thermit automatic crucible, in which the Thermit is reacted.

This type of welded joint is used in refrigerating plants, particularly where ammonia pipe lines are used and where a permanent non-leakable joint is desired. The Thermit process not only eliminates all joints from the pipe installation, but the welded joints are actually cheaper to install than ammonia flanged connections. Another advantage is the speed with which the welds can be made, as two men can easily make from forty to fifty welds per day. One man will face up the ends of the pipe with a special pipe facing machine, while the other follows and does the welding. As no outside power is required, the welds can be made anywhere and the operation is just as economical in the field as in the shop.

It is in rail welding for street railway companies, however, that the Thermit process offers one of its greatest fields of usefulness, as the apparatus is simple in the extreme and enables a few joints to be welded almost as cheaply as a large number.

Street railway companies are realizing more and more the importance of installing permanent joints in place of mechanical joints and welding is the only means to attain that end. The life of the rail depends very greatly on the efficiency of the joint, as the rails always wear out and pound where the joints occur. Furthermore, the welding not only prolongs the life of the rail, but also reduces the resistance in the return electric circuit, effecting a saving in power; but more important still, it tends to reduce damage by electrolysis to water pipes, etc., as the current stays in the rails when they are properly bonded, instead of jumping to nearby water pipes.

In making a rail weld, the Thermit steel is fused around the base of the flange of the rail and also around both sides of the head. The process does not, however, weld the rail entirely with Thermit steel, but an insert steel is placed between the two rail ends and this is heated to a welding heat by the Thermit steel and slag and later, when the weld begins to cool and contract, the insert is compressed between the rail heads and butt-welds to them. In this way a weld of the entire rail section is obtained, but without in any way affecting the wearing quality of the metal in the head of the rail which has to withstand traffic. After the joint has been welded, it is ground to proper form by means of a special rail grinder perfected for that purpose.

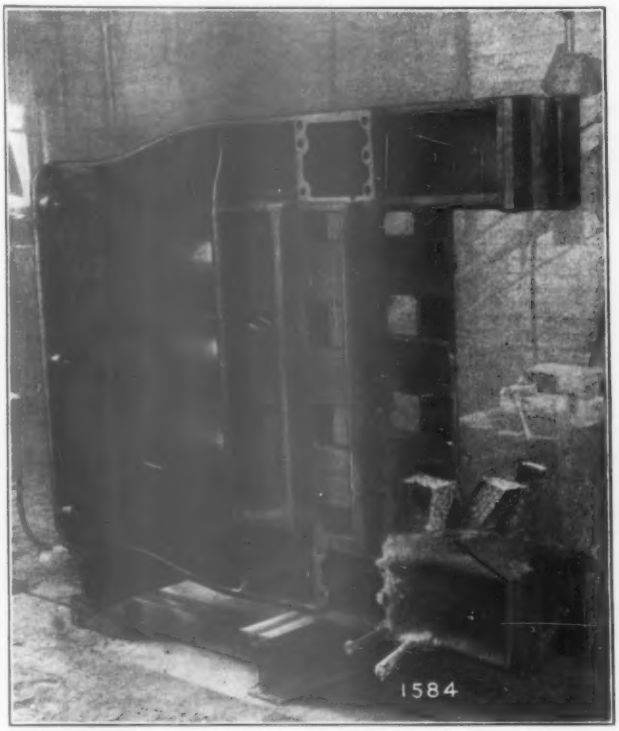


Fig. 10—Cast iron lug of hydraulic elevator pump casting.

In addition to the various applications of the process which have been described, it is used quite extensively in foundries and steel works for reviving dull iron in the ladle and keeping risers of casting liquid. For that purpose it is supplied in cans which can be attached to a long rod and plunged into the ladle or iron or held in the riser. The Thermit reacts and heats up the iron or steel in which it may be immersed.

As time goes on, probably many more applications will be discovered for the process which is now really in its infancy. It may be confidently expected that the wonderful energy so mysteriously and quickly created will be made available to ever widening circles of scientific and technical investigators.

Spanning the Brazos River with Welded Gas Mains

Clever Gas Engineers Put Two 10-inch Welded Gas Mains in Service, Across the Brazos River, at Waco, Texas—Interesting Engineering Problems to Overcome

By C. R. Sutton

One of the most remarkable gas main construction jobs on record was recently completed at Waco, Texas. Two mains of extra heavy pipe of ⅜-inch wall and 10-inch diameter were laid across the Brazos River under unusual difficulties.

Owing to the fact that the Brazos River at this point frequently rises very suddenly, extreme caution had to be exercised in proceeding with the work in order to guard against the pipe and temporary false work being washed away.

Another problem which presented itself for solution by the engineers in charge was the fact that the entire river bottom was covered with deep layers of quicksand.

In spite of these natural barriers, the job was undertaken and completed without a hitch in the original plans. According to reports received lately from Waco, the pipe lines are working satisfactorily in every respect and the engineers who superintend the work are highly elated over the success of the undertaking.

Preliminary to starting this river crossing work, which also included the installation of twelve submarine cables, it was important to accurately ascertain at what depth below river bottom the gas mains and cables would have to be installed to prevent them from being washed out. It was learned during the construction of the new East Waco Power Plant that the formation of the ground above bedrock was uniform in that section of the country. Immediately overlying the rock are eight or ten feet of coarse sand and gravel and above these strata there are alternate layers of quicksand, clay, and fine sharp sand. Test holes drilled across the river, on the center line of the crossing, confirmed this information; the river bottom was all quicksand above the gravel.

It was therefore essential to safety that the pipes and cables be laid well into the top of the gravel strata and firmly anchored therein. To attain this it was necessary to excavate a ditch through about twelve feet of quicksand and into the gravel strata, all the way across the river bed. This required the installation, on the up-stream side of the ditch, of a substantial false work across the river, on which a combined pile driver and derrick could be moved back and forth as the work progressed. Wakefield piles were driven on the up-stream side of the pipe and cable ditch and across the river to protect the excavated ditch from cavings. The Wakefield piles were in turn braced back to the false work, which was sufficiently strong to take up the pressure on the piling.

It was not thought advisable to run the chance of having the pipe washed away from the top of the false work by a sudden rise of the river and the twenty-foot lengths of pipe were therefore first welded together by the oxy-acetylene process into 100-foot sections in the pipe ditch on the west side of the river, well above the water line.

Fig. 1—Joining two 20-foot sections of extra heavy pipe, ¾ inch thick and 10 inches diameter, by means of oxy-acetylene process.

Fig. 2—Falsework erected to permit welding pipe in 100-foot lengths on banks.

Fig. 3—View of operator and complete outfit used in welding pipe sections.

Fig. 4—Making a final weld on 100-foot sections of pipe in mid-stream. Pipe was covered with burlap and asphalt on the bank to save time.

Fig. 5—Another view of operator welding 100-foot lengths together, showing ditch in river bank in background.

Fig. 6—Finishing the installation of the drip-pocket for first pipe line. Pipe is ready to drop into water.

Fig. 7—View of second line just before lowering into water. Page 24.

Fig. 8—Welded pipe floating on top of water. Page 24.

Fig. 9—Preparing 115-pound weights of scrap steel piling to sink welded main. Page 24.

Fig. 10—General view of falsework and suspended gas main across Brazos River. Page 24.

Fig. 11—The final stage—making connection with main pipe line on north bank after both lines had successfully been laid across river bottom. Page 24.

A close view of the oxy-acetylene welding operation is shown in Fig. 1, the gas supply (oxygen and acetylene being furnished from portable cylinders which were moved from point to point as the work progressed. Owing to the fact that beveled end pipe had not been ordered, it was necessary to set the pipe lengths about three-eighths of an inch apart, so as to make a butt weld, using Norway iron welding wire as a filler, fusing the two edges into a homogeneous structure of metal. It required about forty-five minutes to make each joint on the unbeveled 10-inch pipe. In making a welded joint on 10-inch steel pipe with the ends beveled at a 45-degree angle, as now furnished by the leading pipe manufacturers, it is found that only thirty minutes are required, using about 35 cubic feet of compressed oxygen and 21 cubic feet of compressed acetylene. About 14 ounces of filling material are also required, making a total cost of $1.10 for making a joint in this size pipe by the oxy-acetylene process.

These welds were first tested for strength by placing a block under the joint. The weight of two men was supported, one at either end, without affecting the joint, in spite of the leverage of the combined weight of the pipe itself and the men at the ends. A pressure test was later given each welded section by subjecting each to 90 pounds gas pressure without the sign of a leak.

A partial view of the ditch in which the pipe was welded into 100-foot sections is shown in Fig. 2 and a broader view, showing the false work that extended across the river is shown in Fig. 3. The cylinders of compressed oxygen and Prest-O-Lite dissolved acetylene used in making the welds are plainly shown in this phootgraph. After the 100-foot lengths of the submarine section of the gas mains had been welded together in the pipe ditch at the side of the river, at about the same level with the top of the false work, they were pulled out over the false work for the final welds which were made in the shortest possible time. Fig. 4 shows a view of this work, with the portable steel cylinder of oxygen and acetylene shown conveniently perched out on the cross members of the false work.

Fig. 5 shows the operator completing the joining of the 100-foot sections ready for welding to the drip pocket. It will be noted that the welder is followed by a workman painting the pipe with an asphalt coating. Burlap was then wrapped around the pipe and coated with asphalt. A second wrapping of burlap was then given, with a final coat of asphalt.

Fig. 6 shows the 10-inch main being welded to the drip pocket, and also the outlet pipe welded into the top of the drip pocket. When the cast iron drip pockets were received from a point in the central states it was found that they could not be used because these castings were full of tiny sand or blow-holes. There would have been a very serious delay had it been necessary to await new cast drip pockets but the oxy-acetylene process was called on to meet the

Fig. 1

Fig. 3

Fig. 5

Fig. 4

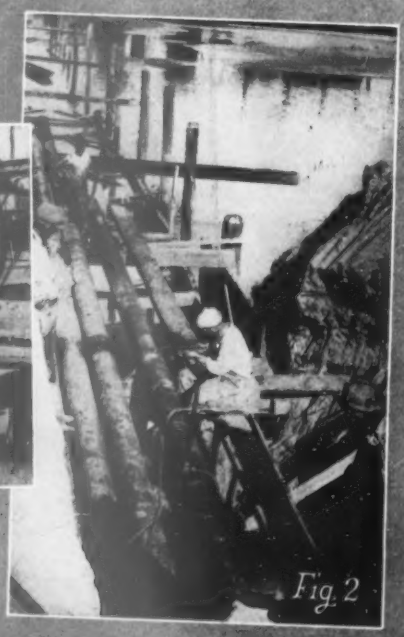


Fig. 2

Fig. 6

Fig. 7
Fig. 8
Fig. 9
Fig. 10
Fig. 11

emergency, and the two drip pockets were quickly and economically made from boiler plate on hand, using the oxy-acetylene cutting blow-pipe for cutting the boiler plate to proper size. By welding all seams with the welding blow-pipe, stronger and neater seams than could be obtained by the former laborious method of punching and riveting were made possible. The new drip pockets were 24 inches in diameter and five and a half feet high when completed. Fig. 7 shows the entire length of pipe, 550 feet, required to span the river with the drip pockets welded on, tested, coated and suspended, all ready to be lowered into the water.

To many it seemed certain that this heavy bulk of metal would surely sink to the bottom when lowered into the water, but true to the assertion of the engineers in charge, it floated on the surface as shown in Figs. 8 and 9. The oxy-acetylene cutting blow-pipe was called into use again in cutting up steel piling into the proper lengths in order that 115 pounds of dead weight might be attached to each 20-foot length of pipe and cause the main to sink to the bottom of the trench in the river bed.

The second 10-inch main to be laid across the river was constructed in the same manner as described above and is shown completed and ready to be lowered into the river in Fig. 10. This picture also gives a good view of the entire length of false work which it was necessary to construct across the river.

Fig. 11 shows both pipe lines coming up from the bed of the river and being welded onto the extension that connects them to the city mains. Very material saving in time and operating costs were effected by the use of the oxy-acetylene process in the work described above and in making up the many special fittings required, thus enabling the completion of the work in unusually good time and satisfactory manner. This installation was superintended by the Phoenix Construction Co. of New York, under the direction of Mr. B. Diem, engineer.

Oxy-Acetylene Welding of Automobile Cylinders

How This Class of Work is Handled in One of the Best Equipped Shops in Chicago

By F. J. Maeurer*

When the oxy-acetylene process was first introduced in this country for the welding of automobile cylinders some years ago, seemingly insurmountable obstacles confronted the welder. A great many times cylinders had more cracks in them after welding than they had before and it was generally assumed that they could not be welded successfully. Even at the present time many users of the oxy-acetylene process feel the same way—a condition that could be easily overcome by giving the question of preheating a little mature thought.

We have welded hundreds of cylinders, from the small single motorcycle to the more modern six-cylinder cast en bloc and have had remarkable success and where we have had failures it could invariably be found (after analyzing the metal) that its sulphur content was very high, causing the metal to be very dirty and brittle—a combination that comes very near making absolute fusion an impossibility.

When a cylinder with cracked water jackets is sent to a shop to be welded it should first of all be stripped of all its working parts. Valve plugs, valves, valve springs and pet cocks should be removed or they will be rendered useless by the heat and all the cracks chipped to a 45-degree angle, this being absolutely necessary to insure a good solid weld, for in trying to burn through with the welding torch you will find that your weld is very good in some places, where you have gotten down to the bottom of the crack, and very weak in other places that you are liable to slight. Then both sides of the crack should be thoroughly cleaned with a file or rough emery cloth, as a majority of cylinders, in high-priced cars in particular, are painted with a heat-resisting paint that makes it very difficult to weld unless it is cleaned off before preheating.

Then put into a charcoal fire on a forge or brick table with the valve ports down and allow to heat very slowly, without using a forced draft, as a forced draft would have a tendency to heat up one end quicker than the other, which would cause unequal expansion, which would surely crack the cylinder before welding is attempted.

Care should be taken to thoroughly cover cylinders, which are to be welded, with asbestos paper or cloth to keep out all draughts and allow it to slowly heat up to about 500 degrees Fahrenheit, or just hot enough that you cannot lay your hand on it; when heated, complete the welding as quickly as possible, then put in the same position as before, cover up all over with asbestos paper or cloth and allow to cool very slowly. Sixteen to twenty-four hours may elapse before it will cool enough for testing.

The idea seems to prevail in the minds of beginners that to preheat an auto cylinder it is necessary to heat it until it is red hot all over, expanding it to its limits, and that really is the cause of so many failures, for the cylinder is sure to crack again in cooling as its unevenness of construction will not allow it to cool uniformly, and will be so warped out of line that it cannot be used again until the valve seats are recut and the cylinder bores reground, compelling the purchasing of oxersize pistons. This class of machine work naturally calls for accuracy, consumes a great amount of time and is very expensive, but can be avoided if the directions noted above are carried out.

The welder must have in mind at all times that it is an impossibility to do good work, regardless of how adept he is in operating a torch unless he purchases the best welding material obtainable, as you cannot do good work with poor tools no more than you can get a 100 per cent weld with a rod that has a tensile strength of but 50 per cent of the metal to be welded, and should only purchase supplies from firms that have made a study of this branch of the industry and who are willing to stand behind and guarantee what they sell.

Superintendent Davis-Bournonville Company, Chicago Shops.

PHOTOGRAPHS FOR WELDERS.

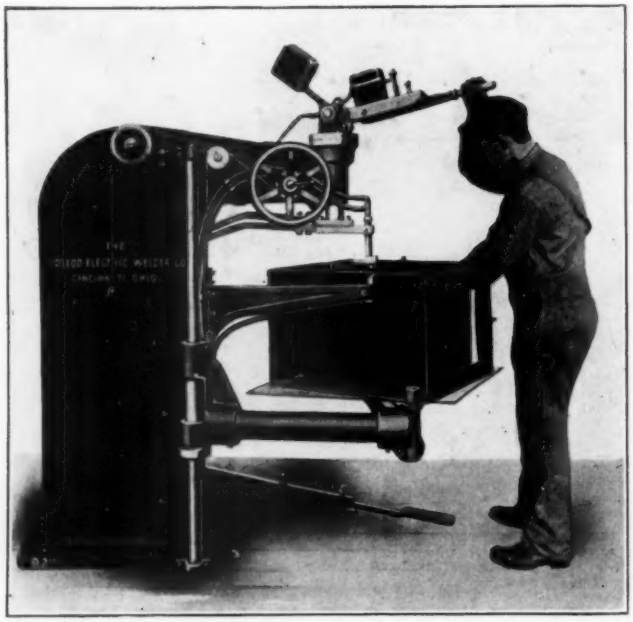
For many of the splendid photographs in this issue we are indebted to Mr. E. L. Ericson, of the Chicago Architectural Photographing Co., Marquette Bldg., Chicago. Mr. Ericson and his staff of operators have long specialized in photographing welding work and are able to make excellent photographs of the most difficult subjects. Usually welding subjects to be photographed are in dark buildings and this work requires skill and experience.

John Vosburg, formerly in charge of the American Ox-Hydric Co., Milwaukee, is now associated with the Star Electric Co., Niagara, N. Y.

Welding High Speed Steel Electrically

Interesting Data on Welding High Speed Steel to Carbon Steel—This Is a Subject Now Engaging Attention of Manufacturers*

The welding of high-speed steel or high-carbon steel to the same kind of stock, or to low-carbon steel, can be accomplished by the electric welding process as easily as the welding of any other kind of metal. The only difference is in the handling of the material after the weld is made. When butt welding two pieces of iron or low-grade steel of the same kind a perfect and homogeneous weld can be made without any subsequent operations. When welding high-speed or high-carbon steel it is necessary to overcome the strains and stresses set up at the junction of the two pieces of metal by holding the heat in the pieces until they are both of a uniform temperature. This "heat treatment" relieves the tension caused by the unequal expansion and contraction of the metals. It is necessary to apply this same treatment when welding dissimilar metals like high-speed steel to low-grade carbon stock. When this is properly done the two pieces are united so perfectly that a lathe tool made in this manner can be forged, annealed and retempered the same as though it were a solid piece of high-speed steel.



Type of spot welders used for welding high speed steel.

In some plants girls operate spot welders.

One type of Toledo Butt Welding Machine used for welding high-speed steel or high carbon steel to a shank of low carbon stock. One thousand pieces of ¾-inch square steel can be welded in a day, and the current cost at three cents per kilowatt-hour would not exceed $1.50.

The cut above shows the operation of a butt-welding machine. The stock is clamped in the viselike jaws of the machine, the current is turned on and the pieces instantly commence to heat. In a few seconds they are brought to the welding temperature and a pull on the lever handle forces the abutting pieces of metal together. When welding two pieces of stock of the same kind, the pieces extend an equal distance from the clamping jaws, but when welding high-speed or high-carbon stock to low-grade stock, the high-speed or high-carbon stock, being finer grained and offering more resistance to the flow of current, will heat more rapidly than the common stock. To overcome this, the stock should be placed in the jaws of the machine with the low carbon stock extending out further from the dies than the high speed stock, as shown in Fig. 1.

This difference will depend largely on the diameter of the stock to be welded, but it will be approximately one-third high-speed to two-thirds low-grade. This can be quickly determined, however, by watching the heat as it comes up. When both pieces heat equally you will know you have them just right. The amount of metal taken up in the weld will be approximately one-half the diameter of the stock. For example—in welding a one-inch bar of stock, one-half inch will be taken up in forcing the stock together, one-fourth inch on each side.

Butt welding is the ideal method of saving high-speed steel, as any stub ends of high-speed can be welded to a cheap grade of carbon stock and used up to the last fraction of an inch. When it is entirely used up, take the same shank and weld another piece of high-speed to it. It is not necessary to saw or forge the high-speed steel to shape, as is required when preparing the stock for a weld as shown in the spot welding method in Fig. 5. No welding compound is used. Heat and pressure is all that is required.

After the weld is made the stock must be immediately placed in a furnace for heat treatment. Strains will be set up that will cause the high-speed steel to check or crack if it is allowed to drop in temperature to any appreciable extent after the weld is made. The stock is heated only at the junctoin of the two pieces as shown in Fig. 1, and when it is taken from the machine, the heat is radiated rapidly and unequally in the high-speed and carbon stock. This condition can be entirely overcome by the heat treatment. The pieces are allowed to remain in the furnace for several hours and cooled very slowly in order to thoroughly anneal them. After this process they can be reheated, forged and tempered the same as the solid stock. This process is being used by drill manufacturers and makers

**This article was originally published in part in the Iron Tradesman. Illustrations by courtesy of the Toledo Electric Welder Co.*

of tools of different kinds that require high-speed or very high carbon steel to be welded to cold rolled or low-grade carbon stock.

Tools of various kinds can be welded, but the work in nearly all cases should be done in the rough blanks. When welding

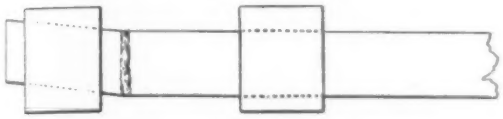


Fig. 1.

a large diameter to a small diameter, the larger diameter must be reduced to the diameter of the piece it is to be welded to, as shown at "A' in Fig. 2. The length of this projection should be one-half of diameter "B." In making the upset, allow one-fourth of diameter "B" and the same amount at "A." For example: If "B" is 1 inch, ½ inch should be allowed for the upset.

A taper reamer can be welded as shown in Fig. 3, but a twist

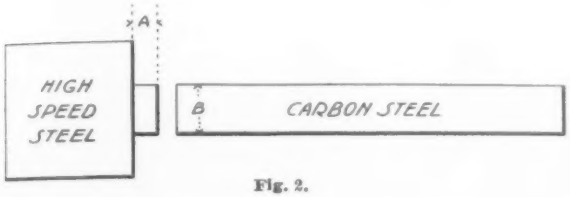


Fig. 2.

drill can not be welded if broken, as shown in Fig. 4, owing to the difference in cross section of metal.

Another method can be employed where it is desired to save small pieces of high-speed steel, and a spot welding machine can be used instead of a butt welding machine. When this method is used, the high-speed steel is shaped as shown in Fig. 5.

Welding high-speed steel insert to a lathe tool. This work

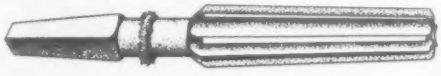


Fig. 3.

can be done in a butt welding machine equally as well. The stock has been formed as in Fig. 5. Eight hundred pieces of ½x½x2-inch high-speed steel can be welded in a day, and the current cost at three cents per kilowatt-hour would not exceed $3.00.

The welds are made between two flat dies in either a spot welding or a butt welding machine as shown in Fig. 6.

Fig. 4.

If the stock is grooved as shown in Fig. 7, it makes an easier welding proposition and less current is required than to weld the flat surfaces. Any manufacturer can quickly determine whether the extra work involved in milling the pieces would prove profitable for his particular requirements or not.

Fig. 5.

The best results are obtained if dimension "A" in Fig. 5 is one-third and dimension "B" two-thirds of the total thickness. This causes the greatest heat to be generated at the junction of the two pieces. If dimension "B" is made proportionally larger the hottest point will be below the junction of the pieces, resulting in upsetting or blowing out of the stock as shown in Fig. 8. If it is necessary to have "B" greater than the proportions given, a special copper die can be used which will clamp the low-grade stock as shown in Fig. 9.

Fig. 6.

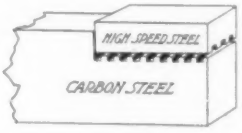


Fig. 7.

Where this is done, dimension "B" is maintained in proper relation to the thickness of the high-speed steel.

In all cases it is necessary that the surfaces F, H, J, I, Fig. 10, be absolutely clean and free from all traces of oil, dirt, rust or scale. The surfaces where the copper dies make contact must also be clean and parallel to each other. It is also necessary to shape the pieces and have their meeting faces perfectly smooth and level in order to get the best results. The

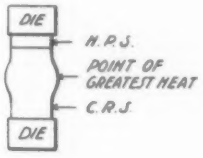


Fig. 8

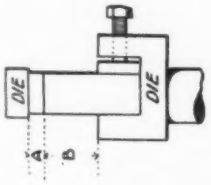


Fig. 9.

current must be applied long enough to bring the metal at the joint to a welding temperature and sufficient pressure must be applied to secure a perfect union at the joint. Toledo Spot Welding Machines with the toggle joint in the head are particularly well adapted for this service, as they give an almost unlimited pressure as the toggle is straightened out to give the final squeeze, but the work can be done equally as well with a Toledo Butt Welder. Welds made by this method can be

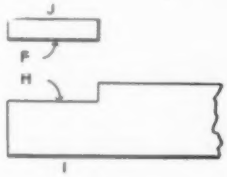
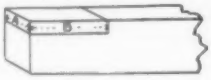


Fig. 10.

ground to any shape desired but cannot be forged after the weld is made. They do not require the heat treatment called for when a butt weld is made, but the pieces can be dropped in an oil bath or rapidly cooled as soon as the weld is completed.

The following tables will give a fairly good idea of the cost of welding, the time required to do the work and amount

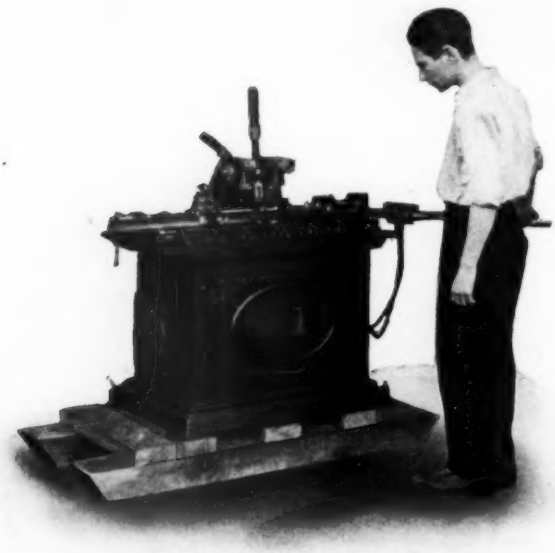


of current it is necessary to have supplied for welding various sizes of stock.

The foregoing remarks have dealt chiefly with the welding of lathe and planer tools and drills. It will be apparent that this process can be used to advantage for welding many other articles, for instance—the shanks to end mills and the "business

ends" of chisels and similar tools may be made of good tool steel and welded to a cheaper body, with a consequent saving in production cost. A great many other tools, such as small punches, taps, reamers, etc., at once are suggested.

Alternating current must be used in all cases, as direct current cannot be used. Single phase current is required, but this can be obtained from any two or three phase source of supply. Any voltage from 110 to 550 volts can be used and any frequency from 25 to 60 cycles.

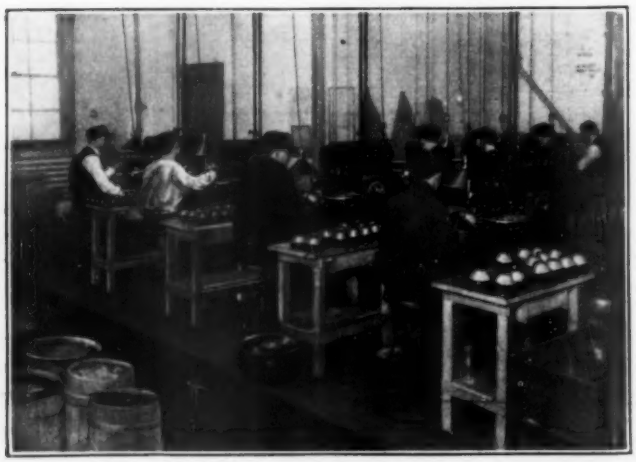


Butt welding machine used to weld high speed steel.

WELDING HIGH SPEED STEEL

Butt Welder Data

Area in Square Inches.	Kilowatts Required.	Time in Seconds to Make Weld.	Cost per 1,000 Welds at 1 Cent per Kilowatt.
.05	2	3	$0.02
.11	3.5	5	.05
.20	5	5	.07
.31	7.5	10	.21
.44	12	15	.50



Spot welding machines in operation.

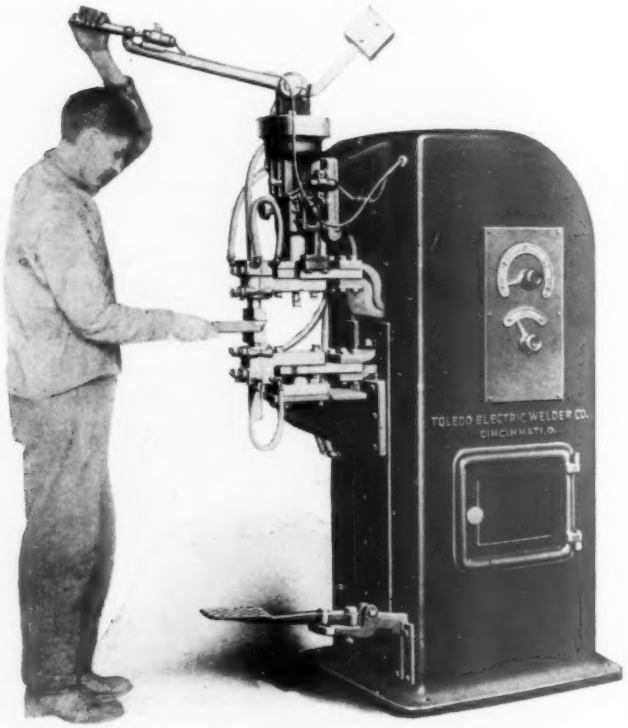
.60	15	18	.75
.79	18	20	1.00
.99	25	25	1.73
1.23	35	30	2.90
1.77	50	40	5.55
2.41	65	45	8.12
3.14	75	50	10.42

Spot Welder Data

"A"	"B"	Kilowatts Required.	Time in Seconds to Weld.	C per 1,0 Welds at 1 C per Kilowa hour.
⅜"	1½"	5	30	$0.
½"	2"	10	45	1.
¾"	2½"	15	60	2.
1"	2½"	20	75	4.

The thickness of the stock will make no difference; only point to be considered in making a weld of this kind is the meeting faces of the high-speed and carbon stock.

As the rate charged for current varies in different pla we have figured the current at one cent per kilowatt-hour give a basis for calculating the cost. Multiply the prices given above by the rate per kilowatt-hour charged by your local electric light company, and that will give your cost for current for 1,000 welds.



Spot welding machine.

Organizing Chicago Welder's Club.

Members of the welding trade in Chicago are endeavoring to organize a "Welder's Club" and a call has been issued for a dinner and preliminary meeting to be held at the Kimball Cafe, 116 West Monroe St., on Wednesday, April 19th. It is thought that it will be possible to interest members of all branches of the trade. We are informed that everybody connected with the trade is invited to attend.

H. P. Harding, general manager, National Ox-Hydric Co., has left that company to engage in other business.

W. S. Hoyt, advertising manager, Oxweld Acetylene Co., has resigned to join the staff of a Chicago advertising agency.

Spot and butt welding processes have completely upset the filing cabinet business. A few years ago wood cabinets had the call, but since the introduction of welding processes steel cabinets have been gaining in favor.

Aluminum Welding—Chapter 2

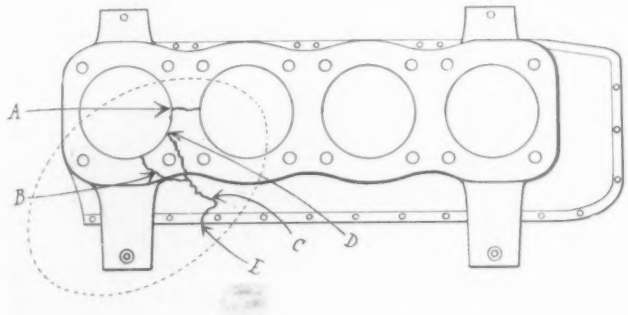
Practical Pointers for the Welder of Aluminum—Those Welders Who Are Called Upon to Handle Aluminum Work Should Read this Article Carefully

By Harry B. Hoover, Oxy-Acetylene Engineer

Low Point of Fusion and Rapid Conduction of Heat

Aluminum melts at a temperature of between 1,100° and 1,200° F. With its low point of fusion and rapid conduction of heat it makes it necessary for the operator to watch it very closely, and the fact that it does not change color under heat, makes it still more difficult for the beginner. A great deal of precaution must be taken when preheating as well as when welding aluminum, *not to get it too hot.* A good indication of overheating is when little bright balls commence to form on the surface of the metal. This is called sweating and when aluminum begins to sweat it is almost at a melting point.

The rapid conduction of heat through the metal allows it to get in a molten condition, for a large area around the point where the heat is applied almost as quick as it does at the very point of contact with the flame. By overheating of this kind, it is possible to melt a whole crank case into a puddle almost without warning, or again you may



melt only the side of it in or a hole in the side of it, accordingly to the size of the heat or flame applied.

So, to make a successful weld in aluminum these difficulties must be guarded against.

Contraction, Expansion, Shrinkage and Alignment of Broken Auto Parts

The contraction and expansion in aluminum is greater than in any other metal, the shrinkage is also greater. The writer believes that 90 per cent of failures in aluminum welding is due to the cause of the contraction expansion and shrinkage not being taken care of properly, causing the case to warp or shrink out of alignment, thus putting it out of commission entirely. But in some instances, such cases can be reclaimed, if not too badly damaged. The writer remembers one case in particular that he reclaimed.

This case had been warped 5/8 inch out of alignment and was ½ inch short on one side, and ¼ inch short on the other. By cutting the case in two, and aligning it properly, allowing for shrinkage, when rewelded, the case was made as good as new and is now in service.

The contraction and expansion is taken care of by preheating and cooling properly. The shrinkage and warping are also taken care of to a certain extent by proper preheating.

There are different methods of preheating, but the most satisfactory way, from the writer's experience, is the use of a preheating torch, such as the ordinary blow pipe using a city gas and compressed air or a gasoline or a kerosene burner, each having their advantages over the other, but either can be used with as equally satisfactory results.

The reason for using a preheating torch (as the writer will call it) in preference to a charcoal fire or a gas oven, is that the heat is under absolute control and regulation of the operator at all times. Therefore, there is less chance of overheating, causing the case to warp, or shrink. The preheating torch is more flexible, allowing the case to be preheated in any position, the most convenient for the operator to work in, and any portion, or all of the case can be heated at will. Of course, it will be understood that the operator should be supplied with a helper, who handles the preheating flame under his direction and in some instances, the operator could use two helpers to a great advantage as will be explained further along.

It is very seldom that you find two aluminum castings that are exactly the same mixture, some have a higher percentage of zinc and some have more copper, etc., consequently, they work under different conditions.

For instance, a case that is of a high percentage of zinc, melts at a lower temperature, and is more brittle and soft when at a high temperature, it also shrinks more under

Paddle for aluminum work, described in March issue.

certain heat conditions and is therefore more apt to get out of alignment from overheating and is subjected more to check cracking in contracting and expanding.

One of the most essential things in welding a case of this nature is to not preheat any more of the case than is absolutely necessary and it must be done as quickly as possible. By the use of a preheating torch, this can be accomplished, quicker, better, easier and more economical than by any other process.

The writer will now take up and explain how to weld a crank case.

The case should be thoroughly cleaned, removing all grease and dirt, especially around the end to be welded. The next thing is to see what condition the case is in. If it has been twisted or sprung out of alignment it will be necessary to pull it back into shape with clamps and straight edges, one straight edge should be placed along the bottom of the case where it bolts fast to the under half. Very small clamps should be used, about 2-inch C clamps are best, the straight edges should be of cold rolled steel about ⅜ by 1 inch or somewhere close to this size and should be a little longer than the case. In putting on this straight edge it should be clamped on edgewise, instead of using the flat sides, this gives it more strength and is not so apt to warp under heat conditions. Do not draw the clamps up so very tight, just tight enough to draw the case to the straight edge using the hands only. If a wrench is used and the clamps are pulled too tight, the case may be mashed or pulled out of shape where the clamps rest against it, especially around where you are preheating or welding, as the heat softens the aluminum as before mentioned. At least two more straight edges should be placed on this case, one on the top side where the cylinders bolt on, and should

run the full length of the case, also one under the two arms, fitting in the same as the frame of the car would.

After the case has been properly aligned and the pieces put in place, it is then ready to be preheated. The case should be warmed up slightly all over, just enough to take off the chill, after this has been done the preheating is confined to that part of the case as shown inside the circle

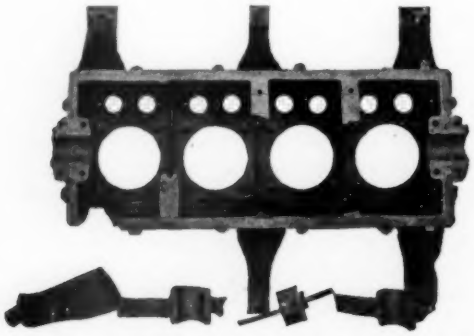


Fig. 1—Aluminum crank case with 1 lug and 3 bearings broken off. This is a difficult job, owing to the alignment of the bearings.

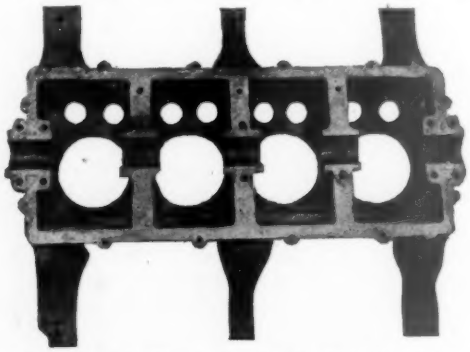


Fig. 2—The job shown in Fig. 1 completed. Note the alignment of the crank bearings.

of Fig. 1. The preheating is to be done with appliances mentioned above or similar to them. The arm should be preheated first gradually, extending the heat around over the area as shown inside the circle, watching it very closely and keeping the arm hotter than any other part of the case, by using a paddle (as shown in Fig. 4, and as described heretofore) to scrape or feel of the aluminum in this way. It is easy enough to tell when the case is hot enough to

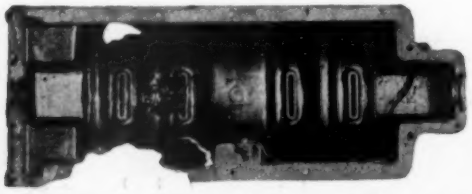


Fig. 3—Two automobile cylinders with bursted water jackets, due to freezing.

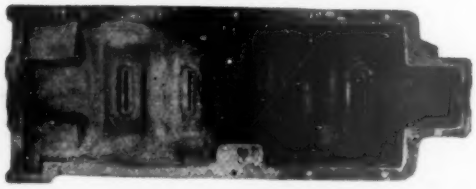


Fig. 4—The cylinders shown in Fig. 3 welded.

commence welding. By scraping the aluminum with the edge of the paddle where it is cold, you will notice that the metal is hard and the paddle will slip across very easily, hardly leaving a mark, but when the aluminum becomes hot, in scraping it the paddle digs right in, when it gets to this heat it is ready to begin welding, the preheating flame should be kept on the arm during the entire operation, keeping it about the same temperature all the time. It is pos-

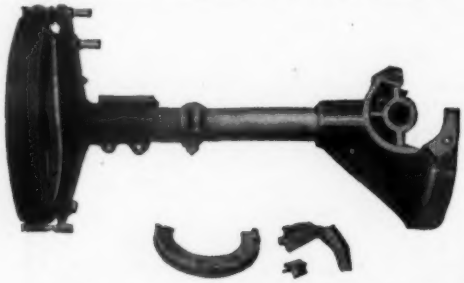


Fig. 5—Badly broken aluminum differential housing.

sible for one man to do this work, if he is properly equipped, but even so two men can do it much easier, and make a better job, however, this will be explained as one man would do it.

Fracture A would be welded first. A tip being used just large enough to bring the metal to a molten condition, the flame should be absolutely neutral. When the metal starts to fuse or melt, take the paddle edgewise and force it down into the crack or break, in this way breaking up the oxidization and allowing the metal to flow together. It may be necessary to dig out some of the metal along the crack in thick places, so as to get to the bottom of the fracture. After the bottom has been reached and the metal flows together, the filler rod should now be used and the deficiencies filled up, keeping the edges of the metal molten and rubbing the filler rods into the metal, so as to keep the oxide broken up and allow it to flow together. Care must be taken not to get the metal too hot, as it will drop through or collapse, leaving a hole, which will require much more work to fill up. This can be avoided by lifting the flame for an instant allowing it to cool, at the same time keep working the metal with the paddle or filler rod, as it cools again apply the flame, bringing it up to a molten condition, working it for a few seconds, and lifting the torch again. This process should be kept up during the entire operation. Of course heavier parts do not need to be cooled so often, but when the metal is thin it is absolutely necessary that it should be allowed to cool in this manner. The under side of this weld, should be smoothed up at the time just before commencing to fill in with the filler rod and do not bother it again afterwards.

Fig. 6—The differential housing after being welded.

Fracture B is the next weld to be made. In starting this weld it should be started at the inside edge, and welded down to fracture C. To get to the bottom side of this weld, it will be necessary to go down through from the top side, welding about 1½ or 2 inches in this manner. Then smooth the weld up on the under side, keeping up this process until the weld is finished.

Fracture C has been left open during the above opera-

tions allowing the case to contract and expand without putting any strain on the welds.

It will be necessary, before starting to make the last weld to preheat the case as before. Then start and make the weld C beginning at the inside edge or top of the case, as indicated by D, and welding down to the outside edge, as indicated by E. Proceeding with this weld as with those previously done.

After turning the case or straightening the weld up on the inside, it would be advisable to again use the preheating torch for a few seconds in each instant.

When weld C has been finished, keep the preheating torch on the arm until the weld has become as cool as the surrounding metal, then cover with asbestos and leave to cool in this manner.

(To be continued)

THE WELDING OF COPPER AND ITS ALLOYS IN THE RAILROAD SHOP

By B. Kopfersmith

Copper is a rather soft metal and is very ductile and malleable. Rolled sheet or tubing has a tensile strength of from 24,000 to 28,000 pounds per square inch and annealed wire over 40,000 pounds per square inch; the best copper welded specimen that I obtained showed on test a tensile strength of 22,000 pounds per square inch. Copper when heated too much or when under the action of the oxy-acetylene blowpipe will oxidize, and form an oxide of copper. Since this oxide will dissolve in metallic copper it is indispensable to use a phosphorated copper welding rod, which will act as a deoxidizer.

The advantages of welding defected copper tubes, such as cracks, holes and worn out spots, over the brazing method, are great in that it will save time, labor and material, be-

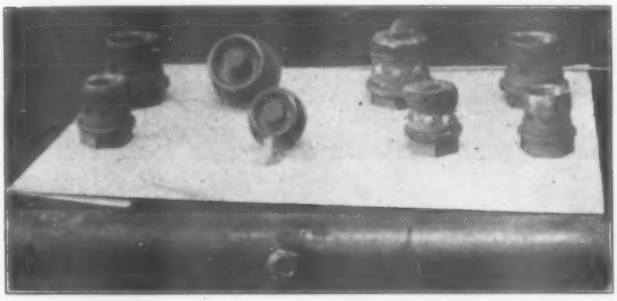


Fig. 1—Four pair air pump cages. Left to right, (1) cages worn out, (2) filled with fire clay at bottom and carbon in center, (3) cages welded, (4) rebored and finished.

sides giving a new appearance, instead of having a number of patches, one on the top of the other. I have at present equipped a portable cart with two tanks of oxygen and acetylene and in most cases the defected pipes are welded on the engine, thus saving time required in removing and putting on the pipes.

It is also a well-known fact that the brazing operation at the coppersmith's fire is laborious and uncontrollable, and many patches applied are leaking and require another operation. In repairing leaky tallow pipes under jacket other than welding it will necessitate either a new section coupled with threaded joints, that are always leaking, or else stripping jacket and machinery for applying a new pipe, which means an exorbitant cost. The cost to weld this pipe with oxy-acetylene is but a small fraction and gives a good permanent job.

Should the operation on any tallow pipe not over 7/8 inch, happen to be at the base, then the pipe is annealed about 4 inches away from the defected part on both ends, and with a Stilson wrench the pipe is twisted in such a manner that the defected part will be facing upward.

Method of Welding

It is important that the edges of the weld should be cleaned and their vicinity should be raised to a cherry red heat, then the fusion of the metal should be undertaken, avoiding the white jet coming in contact with the metal. After welding, anneal welded part. Should a clean looking

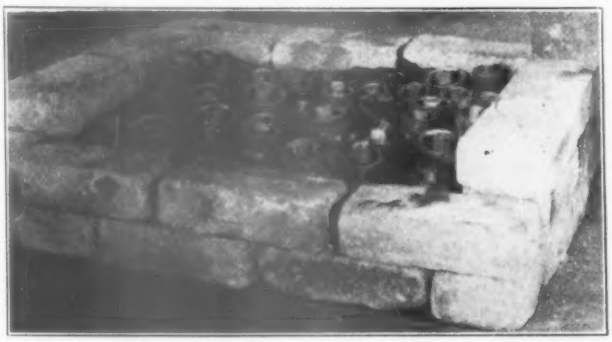


Fig. 2—Charcoal furnace of fire brick for preheating air pump cages.

weld be desired the surface should be filed or ground off even with the pipe.

The welding operation of steam chest or dome cap joints is saving 33 per cent over the brazing operation. The technical advantage of a welded joint is that it is seamless and has a uniform temper, whereas the brazed joint produces a hard spot where it is brazed. The welding rod should be 1/8 inch phosphorated wire.

Place both ends of joints in V-shaped form on a V-shaped iron block 2½ inches square. The size of the V is 3/8 inch.

Fig. 3—Two main rod brasses for locomotive. One on left has been rebuilt, one on right shows method of making mould before welding.

Heat the edges to a cherry red, then fuse the metal adding a little excess metal for hammering. After hammering slightly, until a uniform round shape is obtained, anneal welded part and quench same into water. The joint is then ready for use, thus saving filing, as in the brazing operation.

Copper Alloys

Mixed metals give us alloys, many of which possess useful and valuable qualities not found in the pure metals.

In general the alloys of copper with tin are known as bronze, and with zinc as brass, but zinc is often added to brass to cheapen it or change the color, and tin is often

added to brass to harden it, so that the line between them cannot be sharply drawn.

The alloy of most general importance, from the oxy-acetylene welding point of view, is bronze; a mixture of 77 per cent copper, 8 per cent tin, 15 per cent lead and a trace of phosphorus; another, 75 per cent copper, 25 per cent tin and a trace of phosphorus. Brass is a mixture of 60 per cent copper, 40 per cent zinc.

As in copper, the melting of bronze or brass under the blowpipe is accompanied by the oxidation of the metal, by which it loses a percentage of the tin or zinc. Therefore it is absolutely necessary to use a welding rod that shall act as a deoxidizer. The quality is chosen according to the composition of the parts to be welded. In addition to the rod it is necessary to use a cleaning flux, which cleans the metal and protects the molten surface from oxidation.

Fig. 4—Operator with welding cart. He looks after copper pipe welding on locomotives. Note welding wire at handle. (1) acetylene, (2) oxygen, (3) Pyrene fire extinguisher, for use in case of fire in cab, curtains, etc.

The applications of oxy-acetylene welding to bronze or brass are many, but the most important that are performed at a great saving are the following: Air pump cages, bells, check valves, driving box shoes injectors, lubricators, rod brasses, bearings, valves, whistles, application pistons for distributing valves.

We can generally get together a large lot of air pump cages, to build metal on the inside and at the top seat. This is done at a total cost of 18 cents and the cage is as good as new.

It is important that parts to be welded should be cleaned with sand paper, then fire clay is set at the bottom of the cage (enough to cover the holes in the side). A piece of round carbon about 1½ inches long is set in the center of the fire clay to act as a core. Then the whole lot thus prepared is set in a charcoal furnace made of fire bricks, and preheated to about 500 degrees Fahrenheit. The[re] are removed one at a time from the furnace to the welding [ta]ble. A little flux is sprinkled on the side to be welded. He[at] the cage to a cherry red, then fuse the welding rod, or [lay]er cast new metal in the inside space, and add about [⅛] inch at the top to insure a good seat. If the metal is desired [hard] quench same in water, or else order more tin in the w[eld]ing rod. If desired medium same should be allowed to [co]ol on the table. One operator can weld about 60 in ten [ho]urs.

I am generally building up more material on appli[ca]tion pistons for distributing valves. Clean with sand pape[r] the

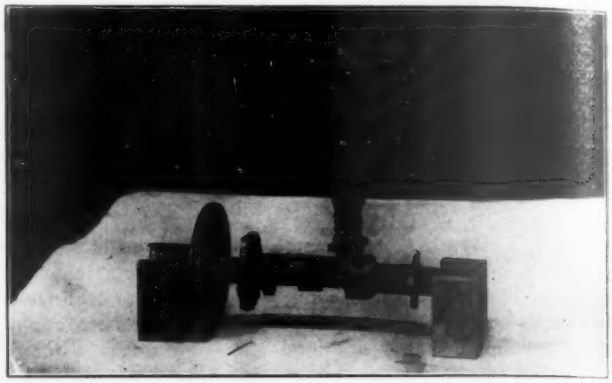


Fig. 5—Two application pistons for distributing valves. Horizontal set is welded at (1) and (2). Vertical set is faced at same points and is ready for use.

parts to be welded, then set the piston on two V blocks. Use ⅛ inch welding rod for building up the bearings. The total cost is 15 cents and the piston is as good as new. On driving box shoes I am building up more metal at the sides, where they are either worn or machined under size. Same should be cleaned and preheated in a charcoal furnace and welded without removing. Care should be taken not to heat them over 800 degrees Fahrenheit. Use a cleaning

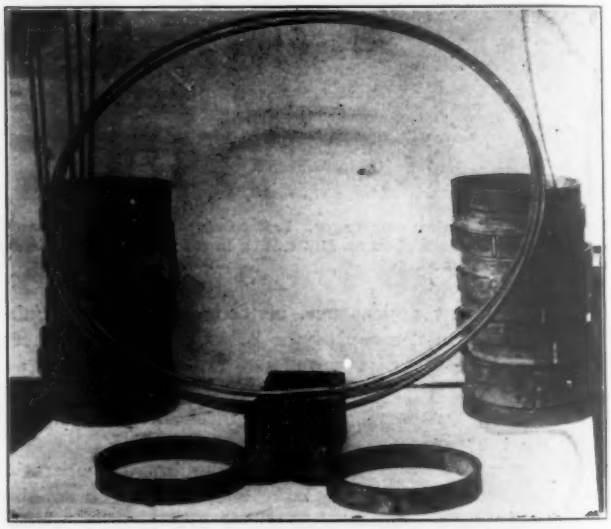


Fig. 6—Copper dome cap joints. One adjusted in V block before welding. Second is welded but not hammered. Third hammered. Also shows 5½-inch superheater flue gaskets. Two in front illustrate before and after welding.

flux and 5/16 inch welding rod. On cracked bells the cracked part is beveled and a ¼-inch hole drilled at the end of the crack. Clean with sand paper, or file about ½ inch on the sides adjoining the crack. The bell is then preheated in a charcoal fire, in a furnace made up with fire brick, to about 600 degrees F. Then the welding is done with a ¼ inch welding rod, using a cleaning flux. After weld is completed it is left to cool gradually. If the original tone

is desired, it is necessary to reheat to about 800 degrees F., followed by tempering in cold water.

Building up new metal on check valves or globe valves where thread is worn out or cut, requires nearly the same operation as in the air pump cages, except that a heavier carbon is set as a core, to correspond to the size of valve, leaving about 5/8 inch space all around for the filling in of metal. Instead of carbon, fire clay mixed with a little powderized borax may be used as a core.

Injectors, lubricators, or whistles, if cracked on the body, should be cleaned and preheated in a charcoal fire to about 500 degrees F., care being taken that the valve parts should be removed if possible. Then proceed to fuse metal and overcharge the line of welding. Let it then cool gradually in the furnace. A 3/16 inch welding rod is used with a cleaning flux.

WELDED STEAM HEATER COILS.

A striking example of the value and efficiency of the oxy-acetylene welding process is shown in the making of large steam heater coils, here illustrated, the welding being out of the ordinary run of such work owing to the size of the heaters. They were built by the Davis-Bournonville Company, at the Jersey City shops for one of the large oil companies, to be used in heating immense vats.

Eight of these heaters were made in one order, and welded throughout. Four of the heaters are 9 feet 10 inches in diameter and 7 feet 2 inches high, and the other four are 8

Fig. 1—Cutting circular holes with torch.

feet 10 inches in diameter and 7 feet high. The larger heaters each have 104 2-inch pipes, and the smaller have 82 2-inch pipes, the headers of both size of heaters being 4-inch pipe. The holes in the 4-inch headers were all cut with an oxy-acetylene circular cutting torch, a total of 1,488 2-inch holes. Fig. 1 shows the cutting of the holes in the heaters, and Fig. 2 shows two operators welding the 2-inch pipes into the header. In this operation the coils were assembled with the upper header suspended from a crane, the 2-inch pipes were placed and several of them were tacked to both headers with the welding torch to maintain position and alignment. When all the pipes were welded to the bottom header, the coil was inverted and the pipes welded on the opposite ends. Owing to the size of the heaters the welding was done outside the shops, and compressed acetylene was used instead of the gas supplied by generators in the shops. When completed the headers were tested to 150 pounds air pressure.

The amount of welding and cutting, the time and gas consumption was as follows:

8 4-inch headers. 8 feet 10 inches diameter.
8 4-inch headers. 9 feet 10 inches diameter.
328 2-inch pipes, 10 feet 7 inches long.
416 2-inch pipes, 7 feet 2 inches long.
16 welds of 4-inch pipe, approximately 18 lineal feet of welding.

Fig. 2—Welding 2-inch pipes into the header.

1,488 welds of 2-inch pipe, approximately 779 lineal feet of welding.
1,488 2-inch holes cut in 4-inch headers, 779 lineal feet of cutting.
Welding time, each 2-inch pipe, 10 minutes.
Oxygen for welding each 2-inch pipe, 6.2 cubic feet.
Acetylene welding each 2-inch pipe, 5.4 cubic feet.
Cutting time, each 2-inch hole, 1 minute.
Oxygen for cutting each 2-inch hole, 1.25 cubic feet.
Acetylene cutting each 2-inch hole, .2 cubic feet.

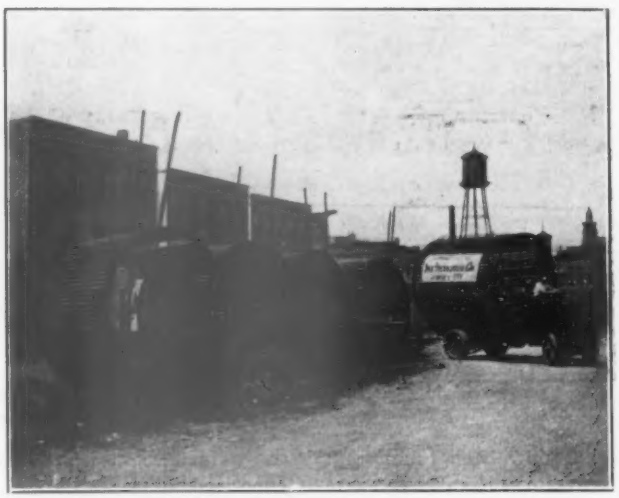


Fig. 3—The finished article.

The Davis-Bournonville Style C welding torch with No. 7 tip, using acetylene under 6 pounds and oxygen under 14 pounds pressure, and the Style C circular cutting torch with No. 2 tip, using oxygen under 20 pounds pressure, were employed for the work.

Welding Steel Barrels with Oxy-Acetylene Torch

The Development of Machines for Automatically Welding Barrels, Tanks and Drums Has Made a Vast Improvement in this Class of Goods

In the manufacture of steel barrels, the longitudinal seam constitutes a principal problem. It is very essential that this seam be one not subject to leakage. A barrel filled with a liquid of the same specific gravity as water will have, at the bottom of the seam, an internal pressure of about one pound per square inch. If the liquid is as fluid as, or more fluid than water, there will be a considerable tendency to leak. When it is borne in mind that it is desirable to bilge the barrel body after the seam has been made, the difficulty of getting the best results will become still more apparent.

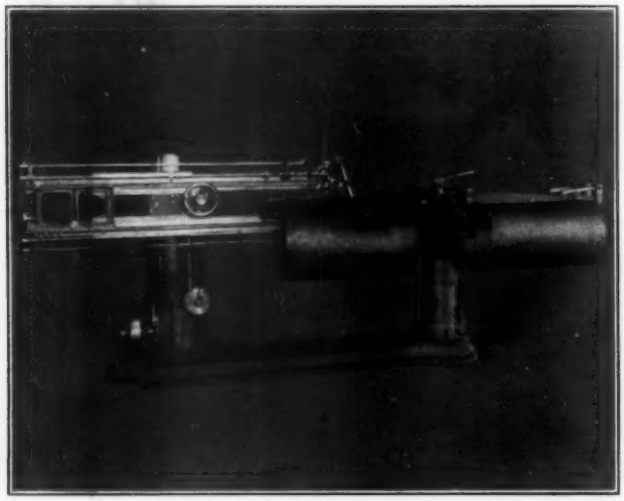


Fig. 1—Duograph with two drums in position.

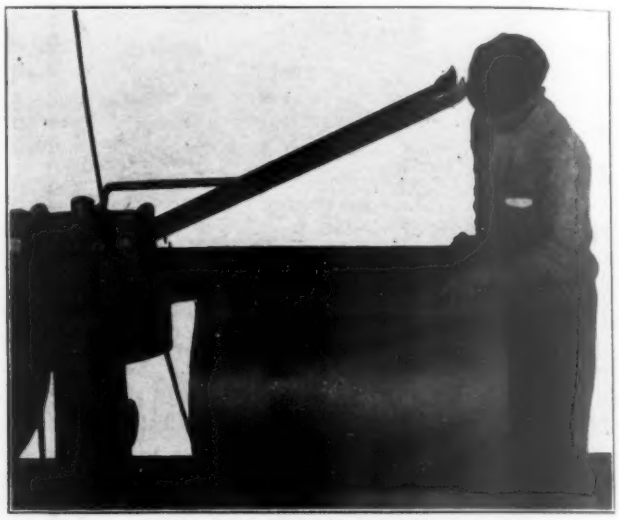


Fig. 4—The finished welded seam.

Fig. 3—Operator starting weld.

Fig. 5—Operator removing welded drum.

It has now been found that a gas-welded seam will prove satisfactory, if sufficient care is exercised in making it. But to depend upon the skill of the welding operator and to give the time necessary for hand operation would make the gas-welding solution of the problem only moderately successful. Accordingly, a machine has been devised which accomplishes in half the time, with comparatively unskilled men, the results of highly skilled labor. The barrel-welding machine consists of two parts: (1) a holding devise which maintains the work in a fixed and accessible position; and (2) an apparatus which carries two torches over the path of the seam. This latter is power drawn. By suitable arrangement provision is made for a considerable range of speed, thus permitting a variety of weights of sheet metal to be handled. The seam is welded before either head is put in; and, in fact, before the bilging of the body is done. There is a double-arm centrally secured to the top of an upright in such way as to permit of rotation in a horizontal plane. Both arms are provided with clamps, which may be locked in position so as to secure the unwelded body firmly in position. The body on one arm is welded by the power-drawn holder of the two torches. While this is going on, the welded body on the other arm is released by an attendant, and an unwelded body put in position. When the welding on the first arm has been completed and the welding apparatus backed out of the way, the double-arm is swung round through an arc of 180 degrees, when welding begins anew. In this way, the machine is operated almost continuously. Two men are

required—one on the welding side. When a certain weight of work is to be handled, a skilled operator or the foreman or some other high-priced man will settle upon the sizes of torches, upon their exact positions, and upon the rate of movement. These matters determined, a comparatively cheap man can run the machine. The man who takes off and puts on bodies is an ordinary helper. A typical barrel body will be a sheet of steel three thirty-seconds of an inch thick, bent to form a hollow cylinder. The edges will have been previously prepared by an upsetting or other operation, so that when brought together, edge to edge, there will be an excess of metal on both sides. The excess desired is very slight. It is needed because the machine operates without the use of welding rods. All the metal that is used is already in the work. This elimination of the welding rod solves at one stroke an otherwise difficult problem. When the fresh material needed to close up the joint is provided the exact amount and exact position of the new material are both cared for effectively.

The machine which is being used for this work is called

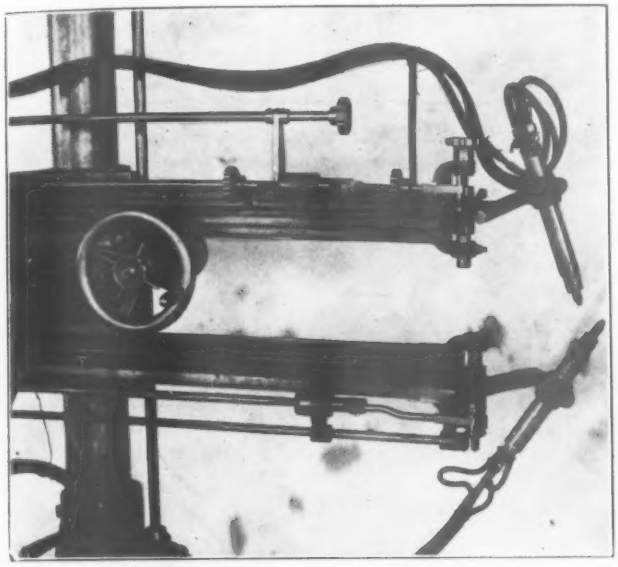


Fig. 2—Enlarged view of sliding torch.

the "Duograph," and it is manufactured by the Davis-Bournonville Company.

The name "Duograph" has been given to the machine as it provides for the operation of two welding torches operating at the same time on both inside and outside of the seam. The terminal, "graph," being used, as several of that company's mechanical devices for welding and cutting are similarly identified, as the Oxygraph, Radiagraph, Holograph and Camograph.

Figure 1 shows the Duograph with two drums in position —the position of the welding torch indicating that one drum has been half welded, the other drum being clamped and ready to be swung into position when the first weld is completed. The drums are clamped into position on water-cooled arms attached to a turret mounted on the pedestal at the right of the machine. A helper removes the welded drum and sets up a new form to be welded on the extended arm, while the operator is welding the other drum. The column on the opposite end of the base supports a sliding frame, to the arms of which are attached standard Davis-Bournonville water-cooled oxy-acetylene welding torches. This sliding frame, or carriage, is moved forward at a determined speed, variable according to the work being performed, the speed mechanism being enclosed in the base of the supporting column, with independent motor. The torches are adjustable to height and angle, and when the carriage is reversed, after completing the welding of the seam, the torches swing out of place to permit reversing of the turret and the bringing of another drum into position for welding.

Figure 2 shows an enlarged view of the sliding torch carriage, with the two water-cooled welding torches in position —the acetylene and oxygen and the water supply being connected with flexible hose to the torch. The acetylene and oxygen supply may be taken from compressed gases in portable tanks, or from pipe lines supplied directly from generating systems. The water supply may be taken from the ordinary pipe line, the water circulating through both torches and tips and through the supporting arms to which the drums are clamped.

Figure 3 shows the operator starting the weld.

Figure 4 shows the finished welded seam.

Figure 5 shows the operator removing the welded drum, preparatory to setting up a new form.

In practice, the two welding torches are employed only for welding the heavier gauges, and on such thicknesses as 10 and 13-gauge steel the best results are obtained by a slight upsetting or expanding of the edges of the sheets to be welded, which gives the necessary added metal for strengthening the weld. For welding the lighter gauges, such as 16-gauge, no upsetting is required and but one welding torch is employed.

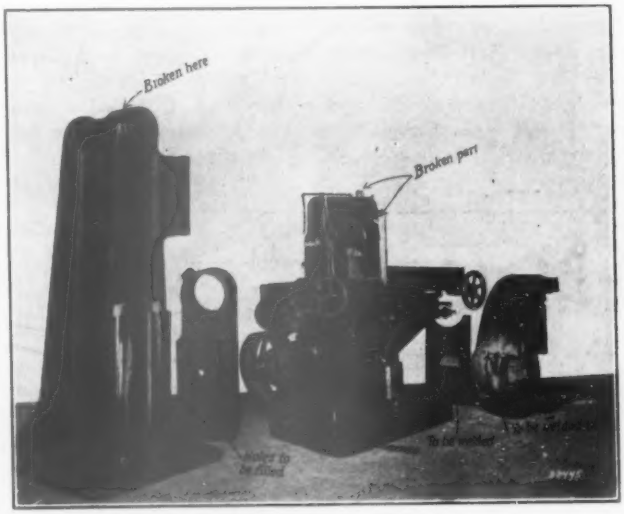
The average speed of welding, with most efficient results, is about 20 drums per hour with longitudinal seams of 32 to 34 inches. The standard Davis-Bournonville torches, using both acetylene and oxygen under pressures, are included with the machine. The helper who removes the welded drum and sets up the new form can tend two machines when they are properly timed.

Efficient welding is accomplished at a speed of from 12 to 20 inches or more per minute and but a few seconds are required to reverse the torch carriage, swing the drum in position, and start the weld.

These machines have now been in practical use for some time.

D-B CO.'S CHICAGO PLANT

The new demonstrating plant and Commercial Welding department recently put in service by the Davis-Bournonville Company at 147 West Austin Ave., Chicago, is in full operation. The new plant is one of the best equipped welding plants in the West and Mr. F. J. Maeurer, shop superintendent in charge, is prepared to undertake any kind of welding or cutting work. Machinery of every kind necessary to finish up work in first class shape has been installed.



Hints for the Welder

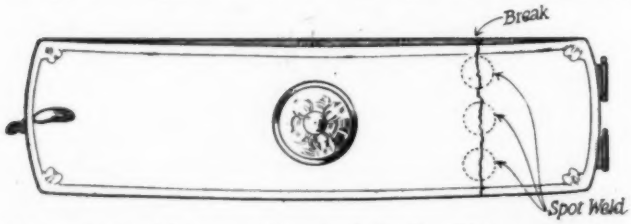
Practical suggestions from practical men. Contributions to this department solicited.

Editor:

This is a small ash pan door for a coal stove, 4x15 in. and about ½-in. thick. I filed the break to weld on the inside, then turned it over and laid on the true side to hold in line. I used a medium size torch tip and passed the flame over the break several times until the break was red hot; then I spot welded where the circles are, being careful to keep the break red throughout its entire length. Next I turned the door over and made my weld on the back side where it would not show.

Back Surface is Absolutely Flat, Which Makes a Good, Straight Edge.

I again brought the entire welded portion to a red heat



and covered with ashes (lime is better). This is to prevent the casting from cracking.

When completed, the door did not look as if it had ever been broken and the owner expressed astonishment at the price, which was only $0.25.

Most of those jobs do not pay a profit, but that one did. He has considerable machinery and you can bet that he will think of me the next time anything breaks.

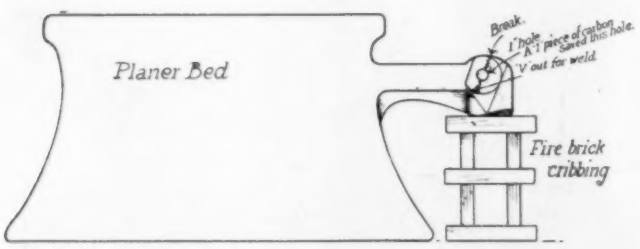
The reason for using a medium size tip is that you can free heat with the torch and make a quick weld, thereby saving considerable time.

Yours very truly,
JAMES L. FRIDDLE.

Albany, Ind.

Editor:

Some time ago the writer was called to a machine shop and was asked if it would be possible to repair their planer, which had broken in the center of the hold in the shifter arm lug. The bed of the planer and the shifter arm were in one casting, the shifter arm extending from the bed and terminating in a lug, 4 inches in diameter and 3 inches



thick, with a one inch hole in the center of the lug. The break had taken place in the lug and had split the center of the hold. Our method of repairing this casting was as follows:

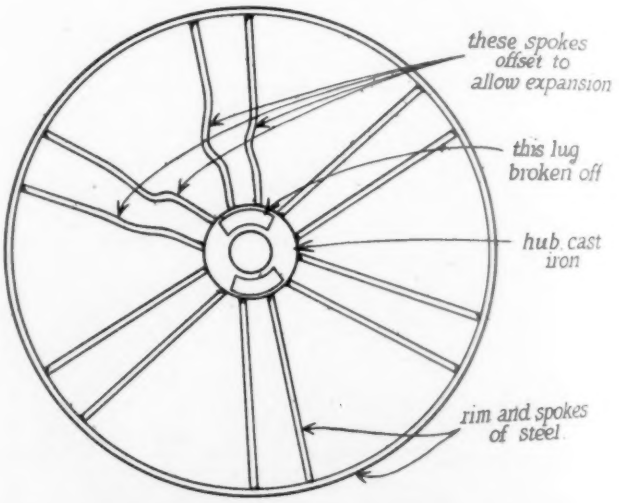
The break of the lug was dressed off to 45 degrees from the bottom up. The remaining part of the arm was dressed off in the same way as per attached sketch. A cribbing of fire brick was built up from the floor to the bottom of the lug. Around this lug was built a mould, made of fire clay and asbestos fiber. A round piece of carbon, one inch in diameter was inserted in the old hole. The mould was so built that when the weld was completed, instead of being round, it was oblong. This allowed us to build it oversize at the brick. No preheating torch was used on this job. By using an extra heavy tip, we soon had the entire lug in a molten condition. It was then only necessary to add enough filling rod to fill out the mould. As the job cooled, the cribbing and mould were torn away and the carbon from the center drawn out. With a one inch reamer, the lug was completed.

The shop wherein this planer is located, is building turret lathes and screw machines; and are working their forces night and day. When we were first consulted on repairing this piece, it was about five o'clock in the afternoon. At nine o'clock that same evening the job was finished and our equipments packed up ready to be taken to our shop.

Editor:

Just to relate an interesting welding job which we have completed and which may be of interest to the welding trade.

We had a large wheel, 5 ft. 2 in. in diameter, cast iron hub, steel rim and steel spokes. While preheating the cast iron hub to weld on a lug the spokes would expand and



raise up hub, so we offset them as per sketch. We welded and after cooling heated the spokes and straightened, making a very successful job of it. When the lug was broken off the hub a section of the hub was broken out also.

C. A. LARSON.

Auto Specialties Co., Elkhart, Ind.

Editor:

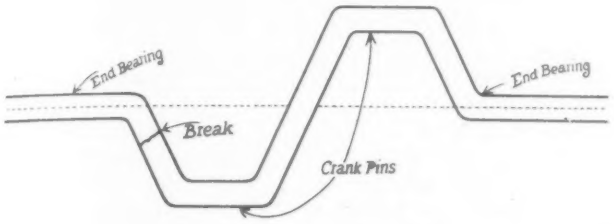
I do not know the name of the piece, but it operates the cycle blades on a reaper and conforms to a crankshaft in action and in duties.

This shaft is of the material commonly called malleable

cast or gray iron (decarbonized cast iron) and is recognized as very hard to weld and make a satisfactory job.

On account of a shaft of this kind needing great tensile and crushing strength, bronze, the usual binding medium, would not stand the strain, but would bend in time and cause some other part to break.

I started to weld with cast ¼-in. rod and welded until several blow holes appeared which I could not fill; then I finished the weld with ⅛-in. Norway iron, being careful to heat the rod and keep the flame on the rod more than on the shaft. I used the cast iron flux on the Norway rod in very small quantity. When the job was practically complete the metal started to burn and I immediately discontinued the Norway iron and used Naval bronze and bronze flux to get a smooth finish. This shaft finished the season and is apparently as good as when new.



If you will study the melting points of the three rods melted into this shaft and the relative tensile strength of the four metals, also the shearing strength, you will see just what I figured out as I went along on the job.

I took the melting points of the various metals as well as the lineal expansion of the metals and posted them in the welding room and I have made a study of the relative tensile and shearing strength of all of the commercial metals, both from practical and theoretical standpoints and find it a great assistance. JAMES L. FRIDDLE.

Albany, Ind.

Editor: Relative to inquiry of W. Moeller in March issue.

I find from experience the only way to preheat a cylinder is just as you describe it, by binding an oven round the job, but start your fire in the bore of the cylinder and allow this to get red hot inside before you apply the fire outside the water jacket. Allow plenty of draft through the bore, to help. I use a pair of moulders' bellows. The reason: The balls of the cylinder bore are nearly always thicker than the water jacket, so if you apply the heat to the outside the water jacket will in nearly every case separate from the inside and cause all kinds of breaks. If heated on the inside first the heat will radiate through the water jacket and allow even expansion.

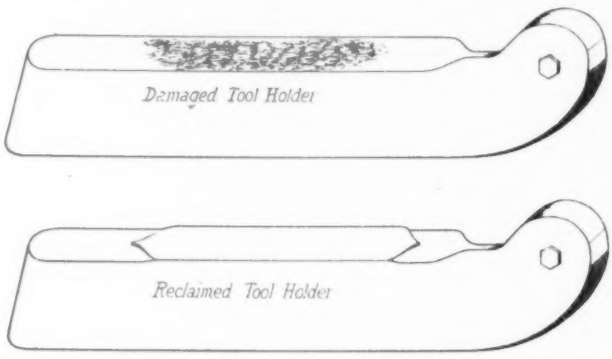
I broke two 400-lb. cylinders before I tried the above, and have had no trouble since.

Fortier, Man. I. JACKSON.

Editor:

We find that machine shops using tool holders are often troubled with the holders becoming worn and badly scarred from the continual pressure of the set screw in the chuck. As the set screw is not always placed on the holder in the same spot, it often happens that three or four inches of the holder's surface becomes very badly chewed up. In this condition, it is impossible for the holder to remain solid in the chuck. These holders can be easily reclaimed and put back into condition by oxy-acetylene welding. A few minutes of labor and 5c worth of materials will put the average holder in good working condition.

Our method of doing this work is as follows: If the holder is greasy and dirty, soak a few minutes in gasoline and brush briskly with a steel brush. It is unnecessary to do any further preparation work than to have the piece clean. These pieces are generally drop-forged. The filling rod to be used, should be high carbon steel, or the same steel as used on low carbon tool steel, or the steel for repairing crank shafts. Place the tool holder between two fire bricks, or preferably two blocks of carbon. The position of the tool should be the same as when in a lathe chuck. The carbon

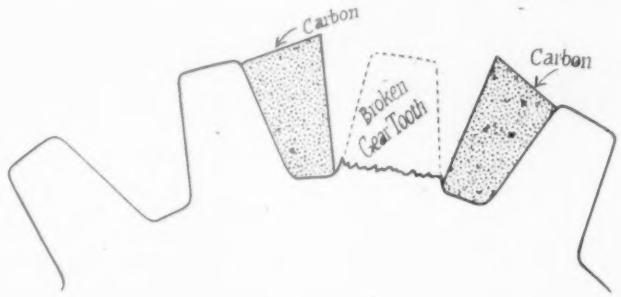


blocks prevent the tool from falling over, and also the filling rod from running over on the sides. It is good practice to build up the tool ⅛ inch and 3/16 inch higher than the original shape. When the tool has been filled in sufficiently bring the entire piece to a white heat. At this point change your welding flame from neutral to a heavy carbonizing flame, i. e., an excess of acetlyene. Play this flame over piece until it has changed to cherry red. Then put in cold water and allow to cool. This will give tool with case hardened surface.

LEO A. BARON.

Editor:

A short time ago we were called to one of our local foundries and were asked if we could repair two broken teeth on the gears of their rattler. The rattler in question was designed to have a blower attached. The ends are made of cast iron and the body of ⅝ inch boiler steel. One end is made in the form of a gear, 36 inches in diameter, which is turned by a pinion about 10 inches in diameter. The teeth in these gears have a 5½ inch face and are 1½ inches deep, ⅞ inches wide at the bottom and ½ inch at the top. The blower was never attached to the rattler, and a number of extra heavy castings, combined with the weight of the sand



in the drum, resulted in the breaking of one tooth in each of the gears. To take these gears off the rattler and transport them to our shop, would have taken two men twelve hours each. We decided that we could do the job in their shop without taking the gears down, and in this way, we finished it in five hours.

Both teeth were broken flush with the rim of the casting. With an extra heavy steel brush, the open space was thoroughly cleaned of all dust and grease. From a block of carbon, two strips, 5½ inches long, were shaped as follows: 1½ inches wide, and ½ inch thick, with one edge beveled. These strips were laid in the open space between the broken tooth and the next tooth, with the beveled edge down,

which allowed the strips of carbon to lean against the good teeth. By using an extra heavy tip it was only necessary to fill in with cast iron until the desired height had been obtained. By using carbon blocks as thick as the space between the teeth, at their base, gives an even width of space to work in. This will leave the new tooth too wide at the top. By removing the carbon blocks and dressing down the sides of the tooth with the torch, good results can be obtained. One tooth was finished in this manner and the other was dressed with a hand motor grinder and heavy files. The first method made a much neater job and was much quicker. In doing this work, we did not preheat or anneal the gears.

After welding the teeth on one of the gears, the writer suggested to the superintendent of the foundry that if holes were cut in the drum, the sand would be allowed to run out, and in this way he could save power by lessening the load in his rattler. He accepted my suggestion. While one operator was working on the pinion, the other operator was putting ½ inch holes in the drum with the cutting torch. These holes were made 8 inches apart, and each line of holes was offset 4 inches from the preceding line. This work was done about ninety days ago. The rattler has been running every day since then, with a full load of war order castings.

We are enclosing herewith a sketch, showing the placing of the carbon blocks referred to above.

Editor:

Enclosed please find photograph of some of the welding work we make a specialty of.

We handle all kinds and sizes of tanks and pipes. In fact, nearly everything that was formally riveted, and find that we can easily compete with riveted tanks or pipes, not only in prices but in efficiency, and appearance.

The method I employ in welding steel is such that our welders all average the following number of feet per hour:

For No. 16, 14 and 12, 17 ft.
For ⅛ and ¾, 10 ft.
For $\frac{5}{16}$ and ⅜, 6 to 6½ ft.
For $\frac{7}{16}$ and ½, 2 to 3 ft.

We have constructed by the welding process, tanks as large as 8 ft. 6 in. dia., 25 ft. long of $\frac{7}{16}$ material, tank to be used for acid storage; we have one now under construction 6 ft. 6 in. dia., 20 ft. long.

We also have constructed by the welding process a few thousand feet of suction dredger pipe which has proven entirely satisfactory, and is standing up under the wear better than the riveted kind, for the reason that it is smooth inside and has no laps or rivet heads to wear off.

Trusting this will be of some interest to you, and your readers, I remain,

A. J. TIMM[illegible]S,
Richmond Machine & Boiler Wks., Richmond, Cal.

Editor:

My specialty is farm machinery, and I believe that I can truthfuly say that I do not let any jobs get away, if it is profitable to the owner and myself to do the work.

I do not take a job without first finding whether it is an emergency job or the part cannot be easily duplicated. This enables me to judge whether it is practical to weld the article or not.

It has been the practice of my competitors in surrounding towns to charge according to the amount of gas and time used on small jobs, as well as large ones.

Farmers whom I know to be reasonable accuse them of being unreasonable.

I believe that the welders who do small jobs will have to take into consideration the worth of anything when welding it or will lose their patrons' confidence in the value of so great a utility to the farmer himself.

He does not worry whether you are making money or not, but wonders if he is going to save money or not.

If his first job costs him more money than the new piece would cost him you have lost a good customer, unless you are particular to explain to him that the time consumed in setting the job up was what made the price so high.

Albany, Ind. JAMES L. FRIDDLE.

Editor:

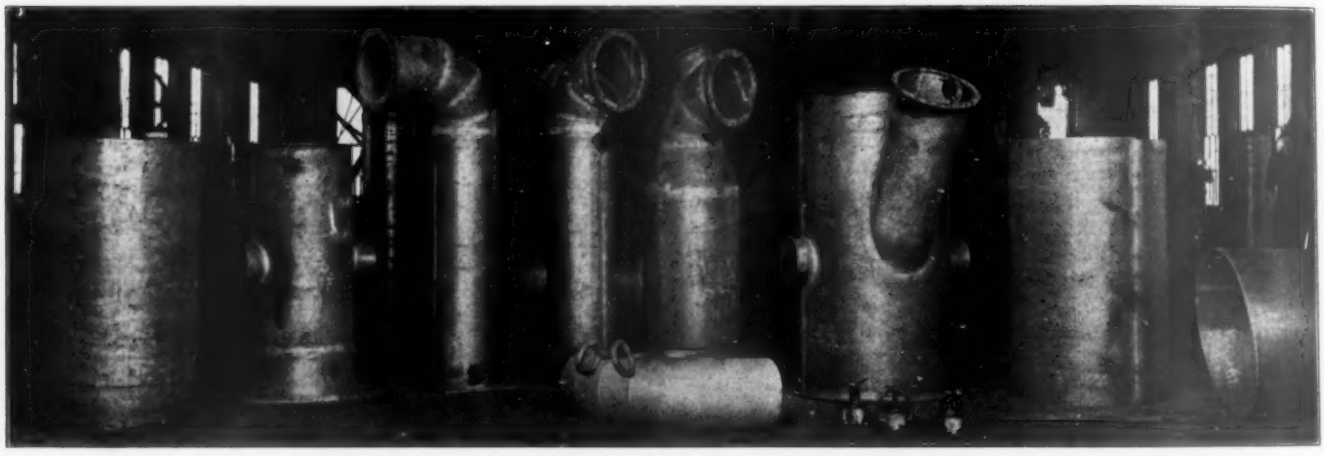
In one of the books on welding that I have they advise welding malleable iron with Norway iron, and from my experience I know different, but why it would not weld as per instruction book I did not know until I read that article by S. W. Miller, of Rochester, N. Y., in March issue, which alone is worth the price of the book.

Deerfield, N. Y. W. J. J. NEWELL.

Editor:

We have tried several different methods of bringing our shop and our work before the general public, and have met with indifferent success, in most cases. One experience proved an exception to the rule.

In October of last year, the business men of this city had a Fall Festival. One of the features was an advertisers' parade, in which we decided to enter a float. When this question came up, many suggestions were offered. We finally decided on the following method:



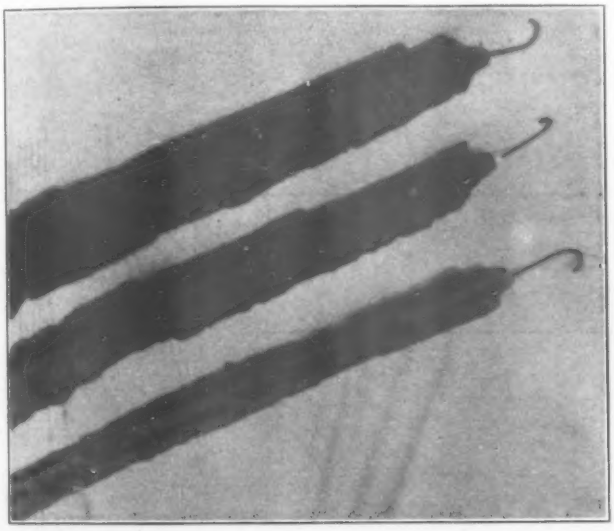
Welding work done by Richmond Machine & Boiler Works, Richmond, Cal.

An ordinary flat bottomed dray was secured. A frame work for banners was built that would allow anything upon the dray to be seen by the spectators. A banner was suspended on each side of the dray, on the outside of the wheels. Another banner was set up four feet above the center of the bed of the dray, running parallel with the side banners. One of the local junk dealers offered us the use of a load of broken castings to complete our float. By selecting castings that had great bulk and little weight, we were able to put a good sized load on the dray. The center banner, which was above the load, carried the following inscription: "WE CAN MAKE THIS LOAD OF BROKEN CASTINGS AS SERVICEABLE AS WHEN NEW." The side banners, which covered the wheels, carried a general advertisement, giving our name, address and telephone number. This float produced very satisfactory results, as we were more than repaid by the jobs that we traced directly to this ad. LEO A. BARON.

Editor:

Last summer a trade journal which publishes some matter for welders published an article on reclaiming scrap nickle anodes. This article was submitted by a well known manufacturer. It is to them that the writer lays the blame of giving out misleading information to welders. Their description of the work was accompanied by a photograph which was reproduced in the journal.

The manufacturer in question estimated that this work could be done at a price of 6 cents per foot. Working on this price, we cheerfully lost about $20 in reclaiming 350 pounds of scrap for one of our local manufacturers. We

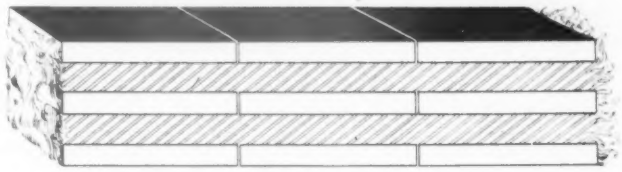


Reclaimed scrap nickel anodes.

have a system of guaranteeing satisfaction in all of our work. It was in keeping up this gaurantee that we lost the money. At the rate of 12 to 15 cents per pound, jobbers in the welding business can make a fair profit, by reclaiming anodes in the following manner:

Making a mould of fire brick and fire clay and asbestos. This mould can be made any size you wish to make the anodes. With a stiff steel brush such as are used in foundries, clean all the pieces of scrap by brushing off the dust and corrosion. You will find this part of the work very dirty and disagreeable. Place a piece of scrap at one end of the mold and be sure that this piece has a hole in it, in which to set the hook. Pack the largest end of this piece in fire clay to prevent melting and to save the hole for the hook. Lay your other piece of scrap edgewise on the bottom of the mould. With your largest sized tip, melt the scrap and add more as you need, to fill the mould to the top.

We are enclosing herewith a photograph of the anodes turned out by us. These anodes are giving good satisfaction and have that advantage over those as described by the manufacturer mentioned. The anodes turned out by us are very nearly uniform in thickness and width. The plating solution works on all surfaces of the anodes at the same time, and if they vary in thickness, they will wear out at



Mould of fire brick, fire clay and asbestos.

the thin spots first and all your work will have very little results.

We are enclosing herewith a sketch showing the way in which we make up the moulds of fire brick and fire clay and asbestos for this work. The original anodes are generally 30 inches long, 3½ inches wide and 1½ to 2 inches thick. By using three-inch fire bricks for each face of your mould, placing them 2½ inches apart and putting some of the mixed fire clay and asbestos on the bottom, and at the ends, leaving the top open, you will have a very serviceable mould for this work. LEO A. BARON.

Editor:

Last spring and summer, the writer was traveling in some of our Western states selling acetylene tanks, oxy-acetylene welding equipments and welders' supplies. I was fortunate in having some practical experiences which often helped me to make sales. The one experience that I consider rather unique I am giving below:

In a small town in Western Nebraska, I called on the proprietor of a garage that apparently was one of the so-called hard customers to deal with. When I introduced myself and informed him what I had for sale, he emphatically told me that there was nothing that I could do for him that day. This call was made about lunch time. After luncheon, I again called at his place of business, and found that his mechanic was trying to repair a badly broken "Bowser filling station" with an oxy-acetylent torch. The mechanic told me that the article in question had been broken that morning and they were unable to sell any gasoline until it was repaired. This evidently accounted for the ill humor of the proprietor. The torch that the mechanic was using was too small to do the work in this case. The mechanic had had very little experience in welding, which also proved in my favor. At that time I was carrying a complete sample outfit of the welding equipments that my company was selling, that is, all except the tanks. I soon had my torch out and had the mechanic interested in it. By a little maneuvering, it was easy to have him suggest that I should see what I could do with the damaged filling station. This was the opportunity that I was looking for. In a few minutes I was attired in regular welding garb, had my equipments set up and was at work repairing the damaged filling station. By 5:30 I had the frame work of this filling station repaired and ready to be put in use again. In the meantime the proprietor had returned to the garage and had become greatly interested in what I was doing. I was taking great pains to explain every move to the mechanic. The proprietor was so pleased at the showing I had made that he gave me a very nice order for a welding equipment, welding supplies and a number of acetylene tanks. He also wanted to pay me for my labor, which I refused.

This is one of several similar experiences that I have had while selling welding equipments. I think that if every salesman connected with this line of business were better acquainted with the practical end of the work, they would have better results.

Difficulties of Malleable Iron Welding

Malleable Castings Are About as Hard a Problem as the Welder Is Called on to Face—The Author of this Article Is One of the Leading Manufacturers of Malleable Castings in the West

The publication of an article on page eighteen of the January number about malleable iron has been commented on by readers.

On the face of the article the statements contained therein are incorrect. Technically, however, they are correct. The definition for malleable is "Capable of being extended through beating." This is true of wrought iron. It is made by beating, it is improved by beating, and it is finished by beating.

All criticisms of the article, however, take it for granted that malleable iron castings are meant, whereas the word malleable was used in the sense that it did not describe malleable cast iron, but wrought iron.

Fig. 1—Micro-photograph of air furnace iron. This iron is similar to that in illustration No. 3 except that the free cementite (the white areas) is of more area, as this iron contains 2.45 per cent carbon. If it were possible to get as much as 6.67 per cent of carbon in an iron it would consist entirely of cementite (hard carbide). Compare this with No. 4, which is the same product after annealing. From this some idea of the tremendous chemical change which takes place in the process of making malleable iron may be obtained.

Fig. 2—Illustration of the second constituent of malleable. A steel containing 1.10 per cent carbon, made up of pearlite (12 per cent cementite—88 per cent ferrite) and free or excess cementite (hard carbide). As the carbon increases the white lines around the grains broaden until in illustration No. 3, where we have 2.45 per cent carbon, the white areas are more noticeable, and in illustration No. 1 the proportions are nearly equal. All steel or iron, if it contains no graphite (when the carbon exceeds 0.85) consist as does the above of pearlite and free cementite. Two or three per cent of steel is used in the malleable mixture.

How Malleable Castings Are Made.

The term malleable iron is applied to a cast iron which has the property of malleability after passing through the annealing process. Malleable iron is made by melting the proper proportions of steel, malleable, hard iron scrap and pig iron; so that when cast the carbon will all be in the combined form and we have what is known as white iron. In the unannealed state, white iron is very brittle and hard and has few commercial uses. The contraction, while cooling, of this white iron is about ¼ inch to the foot, so that the cooling strains are enormous and unless the casting is of an even strength throughout, cracks will develop at the weak point. The same is true if a hard iron casting is heated to a high temperature in spots, which accounts for the extreme difficulty of welding a casting in the hard state without causing the casting to crack at some other point.

After cleaning the hard iron castings of sand that adheres to them from the mould, they are taken to the annealing room and packed in large iron boxes. The packing material varies in different foundries, but the most common material now in use is ground fire brick, furnace slag and iron oxide from the annealing pots; though many other materials are used with success. The principal use of this packing is to prevent distortion of the castings while at the intense annealing temperature.

After packing the annealing pots, they are put in the annealing furnace, where the temperature is brought to about 1,600 degrees F. and maintained at this point for about sixty hours, after which the temperature is allowed to drop slowly to azopt 1,100 degrees F., from which point the rate of cooling does not affect the casting.

During the annealing process the structure of the iron is entirely changed. From the original state of the white iron in which the crystals are large and the carbon is in the com-

bined form, the iron is changed by the annealing temperature to one in which the crystals are small and the carbon is in a free state, known as temper carbon. This change is brought about by the annealing temperature and the slow cooling to a point below the critical temperature. This gives

Fig. 3—This micro-photograph, magnified over a thousand times, shows the structure of white pig iron, which is similar to an unannealed malleable iron. The white area is cementite or what is called the hard carbide, the hardest part of iron or steel. The dark area is called pearlite, which is composed of 12 per cent cementite and 88 per cent of ferrite. The higher the carbon content the greater will be the proportion of white area. This sample contains about 3.50 per cent.

a material that is both soft and ductile, and yet has a high degree of strength.

Now it may readily be seen that if a malleable casting is

Fig. 5—This cut, which is practically life size, shows the test bars which are taken from each furnace, after the castings have been annealed. Each of these test bars are hammered into a spiral to test the ductility. When the attempt is made to hammer it in the opposite direction, however, it breaks as shown in the illustration. This gives a good idea of the amount of strain a malleable casting is capable of enduring.

again heated above its critical temperature and then allowed to cool rapidly, the structure will again change to one similar to its original form, which lacks strength, ductility and softness. This is the condition that takes place when a malleable casting is welded. At the welding point the casting is heated well above its critical temperature and then allowed to cool in the comparatively short time of a few minutes, as against one of several days in the annealing process. This results in a structure at the welding point which has none of the well

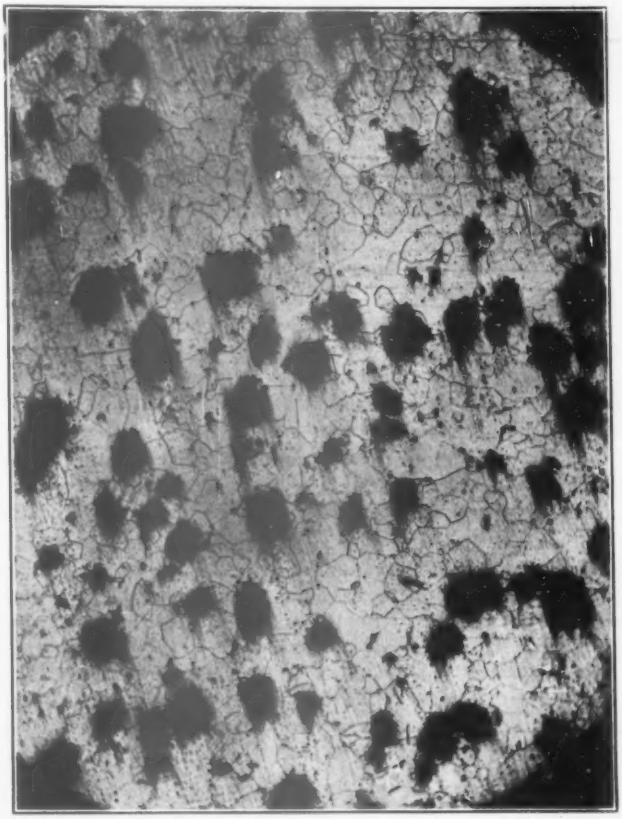


Fig. 4—In this micro-photograph the structure of a well annealed, finished piece of malleable is shown. The white and dark areas, however, do not denote the same constituents as in the case of illustration No. 1. The white consists of crystalline grains of carbonless iron ferrite and the black spots are nodules of graphite. Both of these result from the decomposition of the hard carbides in the white iron. The hard carbides consist of carbon and iron chemically united, 3 parts of iron with 1 part of carbon, forming a very hard compound from two very soft ones. The process of annealing changes this compound back into the two original constituents, which are soft, giving malleable iron its ductility. If a heat over 1250 degrees Fahrenheit is again applied, as it must be to make it flow, the metal is changed back again to the hard compound and a weld which is brittle and lacking in strength results. The fine hair lines show the edges of the nodules of metal.

known characteristics of malleable iron, for at this point the casting is lacking in strength, ductility and softness.

It is possible to weld two pieces of malleable iron together and make them stick, but the metal at this point is of inferior quality and almost sure to break under strain.

Now, the question comes: Why not weld the casting before annealing, and thus allow the anneal to render good material at this point? The reason this is not practical was mentioned earlier in the article in the statement that the local heating of a hard iron casting causes it to crack at some other point.

Many welders report instances of where malleable castings have been welded, some with cast iron filler rod, some with a steel filling rod. The successful welds are found in almost all cases to be on steel castings mistaken for malleable castings, or on cast iron castings not maleablized, which accounts for their taking in the filler rods. Malleable iron castings bend so far before they break that it is almost impossible for the welder to line them up for welding.

A fortune probably awaits the inventor of a process of successfully welding malleable iron that will test up to 75 per cent of the strength of the original material.

W. S. Topping, Bureau of Explosives, will lecture at the Y. M. C. A. May 4th on transporting explosives. This interests welders.

Questions and Answers – Correspondence

The Welding Engineer is very glad to hear from the trade concerning problems to be solved or unique welding work which has been done. We shall be very glad to hear from those readers who disagree with, or have further light to throw on the solution of problems in this department — Editor

Editor: Could you give me information on welding copper wire without leaving it annealed? For instance, heavy trolley wire.

St. Joseph, Mich. E. J. TROY.

Answer: To heat copper anneals it, to heat it and dip it anneals it a great deal more.

It is impossible to weld copper without annealing it. In making a weld of this nature, the weld can be built up and made 1/32" larger than the wire is. Allow it to cool slowly and after it is perfectly cold hammer the weld lightly until it is, or about, the same size of the wire.

This is very helpful to the weld, as hammering the copper hardens it again, the more it is hammered the harder it gets until it reaches a certain degree of hardness.—Editor (h).

Editor: I welded a head in a tank the other day and it leaks, little pin holes came in and they leak. The tank is 38" diameter, about 14ga. sheet steel, the head is of 10ga. steel. The tank is to hold gasoline, and is to be put on a gasoline truck to haul it about the country to deliver gasoline. Now can you help me out by telling me how I can stop it from leaking? I welded the head in with soft steel wire. The job looks fine if it only wouldn't leak.

Shelbyville, Ill. F. P. HISH.

Answer: Your trouble in having pin holes and porous welding in the gasoline tank is due to one of two reasons.

First: You are using an oxidizing flame, that is, an excess of oxygen over acetylene, and thereby burning your metal, or,

Second: You are using a carbonizing flame, that is, an excess of acetylene over oxygen, which causes the steel to melt in bubbles instead of flowing as it should.

If you will properly adjust your flames and keep them that way while you are welding, there is no reason why you can't weld a gasoline tank that will hold air pressure or gasoline.—Editor (m).

Editor:

Dear Sir:

For some time, the writer has entertained the possibility of some day belonging to a Welding organization. I mean an organization made up of welders, manufacturers of welding equipments and supplies, and all people directly connected with the welding business. Oxy-acetylene welders, electric welders, thermit welders, manufacturers of welding equipments and supplies, and manufacturers of products, using any of these methods in their business, to be eligible.

The welding industry has grown with such immense strides in the past few years, that few people outside of the business know anything about it. What is being done by the various processes of welding is unknown to the general public. The public at present is better acquainted with other scientific developments, that are by far of less benefit, from a standpoint of general good. As a point of economy, a welding organization would be of immense value to the public and the trade. We are at present living in a mechanical or metallic age. Every town and city has one or more junk yards that represent thousands of dollars of waste that could have been saved by a competent welder.

Ignorance of welding processes is not confined to the public. There are a great number of men in the welding business who know little of what they should, and also what they should not do. This ignorance is not from choice, but is a result of the present system of selling welding equipments. The average man desiring to learn the welding trade, has not enough money to take a course at some school and then purchase his equipment. The manufacturers of high priced equipments are willing to instruct the purchaser, but the price of their equipment leaves very little for car fare and hotel bills while taking up their course. The common result is that the purchaser gets an equipment and a fifty or one hundred page book of instructions. He reads over this pamphlet and then tries out his knowledge on the general public. The result is that his first customers very seldom care to remember him with favor, and the process falls into local disrepute.

An organization made up of the people connected with the welding industry could do an immense amount of good by overcoming some, if not all, of the defects referred to above. For the benefit of the general public, it could carry on publicity campaigns that would reach the people. Every city has its manual training school; as welding is a public economy, the manual training school should be the place to make this economy known. A good lecture on this subject with a demonstration, would be sure to pay the student in after life. For the welder and the man who wishes to become a welder, a complete course could be mapped out that would cover the various subjects and not simply refer to them. I have read not a few books on welding and, sorry to say, that it has been impossible for me to understand everything that these books contained. They are either too technical or too vague to be assimulated by the average reader. A real course of study in welding would be of untold value to the world at large.

Another big feature for the organization, would be the removal from the market of unsafe apparatus and inferior supplies. This could be accomplished by setting a standard for manufacturers and allowing membership only to the manufacturers who have complied with the specifications of the organization. No reliable manufacturer would object to such a procedure.

I have been connected with the oxy-acetylene industry since July, 1913. In that time I have had occasion to meet the trade in eight of our Middle Western states. The idea of such an association is, by no means, original with me. Several times I have met men far removed from each other, that have expressed the need of such an organization.

My idea of the greatest good that can be done for the welding industry is the organization of a trade association that would have for its object the general welfare and promotion of the welding business. *The Welding Engineer* is today, the paper for all people interested in welding. Why not use your efforts to promote such an organization? I am sure that there are many others connected with the business that will agree with me on this subject.

Los Angeles, Cal. NICHOLAS E. KOCH.

Editor:

I am very glad you have started an inquiry department and think it will be a great benefit to us all. I have had some trouble and am going to ask for some information.

I have welded two cast brass return bends into brass pipe for a waterback and cannot get it tight. When the stove was sent new, these pipes were threaded and screwed together, but in a very short time they all leaked. I welded the joints and tested with cold water at 80 lbs. pressure, and they seemed tight, but in less than a week they were leaking again; then I took them out and rewelded, and now they are giving trouble again. Would I get a better job if I had reamed out the threads and only slipped the pipe into the fitting, say, ¼ inch?

I have had some trouble with iron pipe the same way in a chemical factory. Would I get a better job here if I discarded the threads? Thanking you in advance for any information you can give me on these jobs, I remain,

CHARLES P. ASHLEY,

Kingston, N. Y.

Answer: From the nature of your trouble, it seems as though you had burned the metal and caused it to be porous, or full of pin holes, and the fact that it did not leak at first under cold water pressure was no doubt due to the flux used, which had formed a scale or film over the porous places sufficiently strong to make the weld tight under the test given, but after the casting had been put into use, the heat and the hot water softened or dissolved the flux and ate its way through, causing a leak.

In welding brass, care should be taken not to get the metal hot enough to burn it, an indication of overheating or burning of the metal being a white smoke arising from the weld. In this case the torch should be lifted and the flame held farther away from the weld, holding it just close enough to keep the metal in a molten condition and build up around the joint, using tobin bronze or manganese bronze for a filler rod, as these alloys are better adapted for welding than soft brass wire.

The threaded joint would be of no disadvantage in a case of this kind; in fact, it would be better than a slip joint.

Your explanation regarding the welding of iron pipe in a chemical factory is hardly sufficient to be given a direct answer. The way I understand it, however, is that you have tried to weld pipes that are used to conduct chemicals. The trouble here undoubtely is that the chemicals used in the pipes have some bad effect on the metal while under high temperature, and in this way cause the weld to be defective. The screwed joints would be preferable here also.

It would be advisable in this case to clean the pipes thoroughly around the joints to be welded, and in making the weld to only melt the surface of the metal sufficiently to build up on and around the joint or crack, instead of melting down into the pipe and making the weld through, as in ordinary welding; but put on enough metal in this way to make a strong and tight joint. In making a weld in this manner it might be posible to get away from or eliminate the effects of the chemicals, as it would not be necessary to get the pipe so hot in making a weld of this nature.—Editor (1).

Editor:

Please state all metals that can be welded to each other and what kind of flux to use on each one.

Elkhart, Ind. Leo A. BARON.

Answer: Aluminum can not be welded to brass, cast iron or steel. Any metal that can be welded with the oxy-acetylene flame (except aluminum) can be welded to one another. In welds of this nature a filler rod of the metal fusing at the lowest temperature should be used; for example, in welding steel and cast iron, a cast iron filler rod would be used and cast iron flux; in welding cast iron and brass, a bronze filler rod would be used and a brass flux, etc.—Editor (2).

Editor:

As to the value of your magazine, we should like to ask for further information. In your issue of February, the question of welding springs is answered by you, and we are anxious for further information on this subject.

You state the common fault is the failure to retemper springs. I would ask how many spring makers today temper their springs?

Another question is regarding the metal for filler. In the first place, the spring is a special steel, and the tensile and elastic strength have been improved by working it under the rolls, or drawing under the hammer. If the filler is not as the spring is, can you retemper this spring and have the filler tempered with the same degree of springiness?

Also, how can this filler have the same tensile and the elastic strength of the piece that has been worked in the rolls, and without those same conditions, will not this weld always be a weak spot?

Have had several years' experience in forging steel in different ways, and welding with a blacksmith fire and oxy-acetylene process. I am anxious to learn more in regard to steel and welding springs. Would you kindly enlighten me further on this subject?

E. S. KIMBALL,

Mgr. Oxy-Carbi Co., New Haven, Conn.

Answer: If there is a manufacturer of springs in America who is not tempering springs, we have never heard of him. Of course, we refer to springs used in body construction. Most of the small wire springs are made from oil tempered wire and are not tempered after manufacture.

You are correct in your statement that springs are manufactured from special steel, but we disagree with you when you state that the tensile and elastic strength has been improved by rolling or drawing. The tensile strength might be increased but the elastic limit would be materially reduced. It is possible that if there was a slight difference between filler rods used and the spring itself that the spring could never be re-tempered to correspond with its original structure and if this is true it might properly be assumed that there will always be a so-called weak spot in the spring. We doubt very much, however, if the spring would ever break at the weld if the job had originally been done in a workmanlike manner.

If you know of anyone who manufactures elliptic springs and who does not temper them, we would be pleased to have the information.—Editor.

Editor: I want to make three or four tanks for acetylene. What would you advise me to put into them, asbestos or mineral wool, and if asbestos would it be best to put it in layers, or just crumbled up and packed in solid? Where can I get valves for same that will fit connections?

Grand Rapids, Mich.

G. L. GUNTHER.

Answer: The construction of a dissolved acetylene tank is such that the manufacturing of them should be undertaken only by men skilled and experienced in this work. In the first place, the few tanks you want will undoubtedly cost you more, before you get through, than you would pay on the open market and you will not find any responsible acetylene compressing company to refill them. Acetylene compressed in excess of two atmospheres in "free" form (i. e., an ordinary empty tank without porous mass or filling) is a dangerous commodity, its use and transportation is prohibited by all regulations, fire insurance, municipal and federal. Acetone alone in the tank does not lessen the danger.

The employment of a porous filling is to overcome these dangers. The acetone is contained in this porous mass, each

pore containing a minute volume of acetone. The gas in turn is contained in the acetone, thus the acetylene is divided into myriad volumes instead of being in one large volume, as is the case when the filling is not employed.

It is essential that this filling not merely be **made** correctly, but it will **remain in that condition,** for there is no absolute way of knowing that the filling is O. K., short of cutting open the tank. Engineers have spent years of close study and large fortunes in working out these problems and this work should be left to men of that sort.

If your filling is not properly constructed it will collapse through pressure or vibrations, for, remember that but 20 per cent of the filling is material, 80 per cent being space. This collapse means free space in the tank and after all your work and expense you would have a container as dangerous as a "free" gas container—more so in fact, for all concerned in handling it will believe it to be a safe commodity instead of a dangerous one.

If the tanks are to be used in insured buildings they will first have to pass the scrutiny and careful tests of the Fire Underwriters.

If they are to be transported they will have to also pass the watchful eyes of the Interstate Commerce Commission —which testing will be done by the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, 30 Vesey Street, New York City, Col. W. B. Dunn, chief inspector.

The Interstate Commerce Commission have issued a very complete set of regulations and specifications covering the construction and testing of these tanks—copies may be obtained from Col. Dunn's office.

We could not give you written instructions covering the construction of these tanks, they would be voluminous and would not suffice.

Our recommendation to you is to not undertake the job as you are endangering life and property.—Editor.

Editor: Regarding the question of Wm. Moeller concerning the preheating of his air compressor job, although your answer in the main was correct, I would like to slightly differ from it in several ways. In the first place, you state he introduced internal strains in heating, which was correct and then you go on to show him the proper procedure, i. e., to heat it evenly, and state the way to do this is to build an oven around the casting, fill the oven and cover over the casting with charcoal and light the charcoal. Now that is where I think most mistakes are made in preheating, especially in cylinder work, as this method of heating does not heat the casting evenly, in fact, in most cases and especially in the case of stationary gas engines the heating is very uneven. To explain: cylinders with water jacket cast en bloc are in most, if not all cases, cast with the cylinder wall thicker than the water jacket, consequently by preheating as you suggest the jacket being thinner and being in closer proximity to the fire takes the heat more quickly than the inside wall of the cylinder and expands more quickly, the result being in some cases, especially as I stated before in stationary engines of the International & Fairbanks-Morse design, the breaking of the mouth of the cylinder and in others the warping of the cylinders. Now in the experience which I have had and which I may state covers a period of about nine years, I have found that almost any automobile or other cylinder can be heated and guaranteed not to be warped by the following method, which I think is the only logical way, as you know a cylinder takes the heat in ordinary working conditions from the inside due to burnt and expanding gases. In the case of automobile cylinders our shop practice is as follows:

The cylinder is placed in the oven head downwards and raised about half a fire brick high from the table, then lighted charcoal is put into the bore and the cylinder is left until the heat has penetrated through to the [illegible] that you cannot place your hand on it, and then [illegible] is made as you state outside and the cylinder he[illegible] to a dull red heat, welded and left in the fire cover[illegible] to cool out with the fire. The same procedure is o[illegible] with large stationary engines and in all cases wh[illegible] inside wall is thicker than the water jacket. No[illegible] Editor, I hope you will accept this small criticism [illegible] spirit in which it is given, that is, from an educationa[illegible] and kindly answer me the following question: Ho[illegible] that oxy-hydrogen is used when cutting heavy [illegible] place of oxy-acetylene? My theory is as follows:

The products of combustion in oxy-acetylene are [illegible] that is at the extremity of the white jet, carbon mo[illegible] and hydrogen, and lastly carbon dioxide and water [illegible] and in oxy-hydrogen water vapor exclusively. Now [illegible] vapor being an oxidizing agent and being produced ex-clusively by the oxy-hydrogen flame and cutting being only oxidization of the metal at the point being cut, the oxy-hydrogen flame aids this process more so than the oxy-acetylene flame, as in this flame the cutting being done at the point of the white cone and the products of combustion at this point being as before stated, carbon monoxide and hydrogen, which gases have the property of taking care of any accessive oxygen and thus avoiding burnt metal, neutralizes the effect, which one would naturally expect to take place with the temperature being so much higher than the oxy-hydrogen flame.

Trusting you will answer this at your earliest convenience and thanking you in anticipation, I beg to remain,

J. WATERS.

St. James, Winnipeg, Man.

WOMEN IN OXY-ACETYLENE WELDING

Oxy-Acetylene welding is the latest work to attract female labor in England, an industry itself in its earliest stages. The success in the introduction of women into British industries and vocations calling for much skill has been remarkable in the last eighteen months, remarks an English paper, and every day seems to bring a fresh surprise in this direction. Ever since the active service branch of the National Union of Women's Suffrage Societies was formed it has kept to the fore a program of practical effort and last September the first school for the teaching of welding to women was opened. Six weeks' training is usually enough to equip a girl to take her place in a plant. Even before the war there was not an abundance of men doing this work, for the temptation with them when they had attained proficiency was to go to the still better paid labor of cutting metal with oxygen.—*Iron Age.*

LECTURE FOR WELDING TRADE.

Members of the welding trade in Chicago will have an opportunity of listening to a lecture to be delivered by Mr. W. S. Topping, Assistant Chief Inspector, Bureau for the Safe Transportation of Explosives on the Interstate Commerce Regulations. The lecture is to be given in the evening of May 4th, at the Y. M. C. A. Auditorium. Manufacturers and welders alike will be interested. The Chicago office of the Bureau is located in the Transportation Building and is in charge of Mr. H. P. Conreye, Special Agent. (Harrison 273.)

Patent No. 1,177,726, covering an electric lap welding machine as perfected by Mr. Frank L. Sessions, Lakewood, Ohio, has been assigned to the Standard Welding Co., Cleveland, Ohio. A description of the process was printed in the Patent Gazette for April 4th.

The January, 1916, Supplement to the July, 1915, list of manufacturers of inspected mechanical devices has been issued by the Underwriters' Laboratories, 209 E. Ohio St., Chicago. A copy may be had on application.

Quality = *Guaranteed* = Quantity

Write US About Your Acetylene Supply

Commercial Acetylene Railway Light and Signal Co.

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EAST DEERFIELD, MASS.
TORONTO, ONT.
SAN FRANCISCO, CALIF.
MOBERLY, MO.
W. BERKELEY, CALIF.

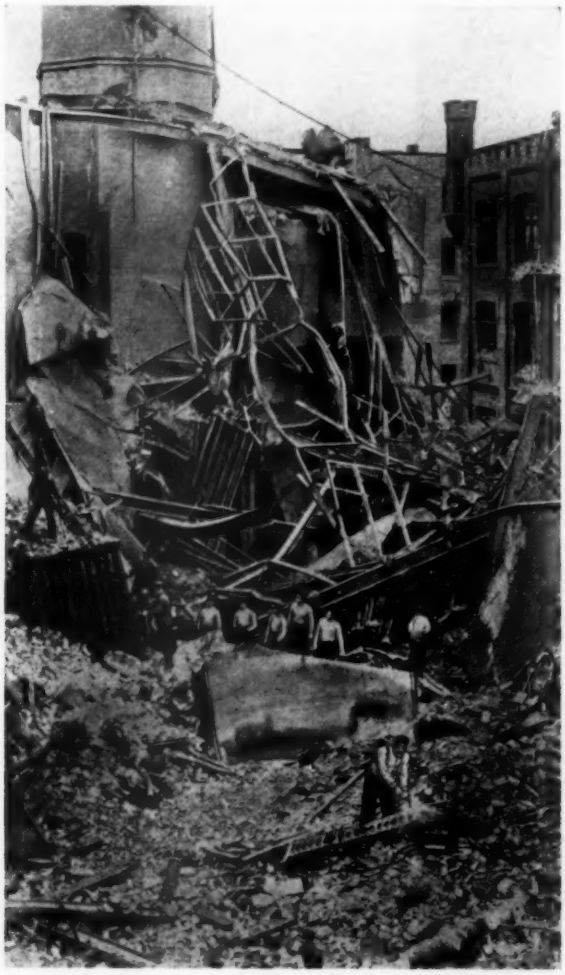
A WELL EQUIPPED SHOP*

The Vilter Manufacturing Company of Milwaukee, Wisconsin, has been engaged in the manufacture of refrigerating plants and machinery, also of Corliss engines for many years.

The welding equipment used by this firm is one of the most comprehensive although not the largest, in the United States. Their product is an illustration of the fact that welding has come to stay with a marked increase in the strength of joints and a decided decrease in the cost of making the joints.

The Oxy-Acetylene System

All tanks used in the manufacture of refrigerating plants by this firm are now welded instead of riveted. The nature of the gases used demands an absolutely gas tight joint as ammonia fumes are decidedly dangerous and it was long ago



Wrecking steel girders with oxy-acetylene apparatus.

proven that a riveted tank even if the seams were well caulked was subject to leaks. Small tanks made of 12 gauge sheet metal or of less thickness are welded with oxy-acetylene apparatus. This saves not only riveting but brazing to make them gas tight.

Castings of all kinds, except the largest cast iron or steel, are welded with the oxy-acetylene torch. Cutting of steel and iron, including openings in the tanks, doors, manholes, etc., is accomplished with the oxy-hydric torch as hydrogen carries sufficient heat for the preheating flame, making a neater cut than the oxy-acetylene cutting torch.

The Electric Arc System

All heavy tanks are welded by the arc system, No. 500 ampere motor-generator set, shown in the illustra[tion] is used with a capacity of from four to six welder[s]. The welders use a shield containing light refractive glas[s] while welding and the welding platform is curtained off fr[om] the rest of the shop to prevent danger to the eyes of the [pass]ous and those unprotected by the shields. For steel w[ork] ing,

The possibilities of making irregular cuts are many. This work was done with oxy-acetylene torch.

the arc is used at the end of a metal rod placed in the end of the holder, the arc melting off the end of the rod and also heating the surface of the steel to the receptive point. For heavy castings, a carbon rod is substituted to make the arc and a separate metal rod fed to the weld.

In this manner the great difficulty of building refrigerating systems has been overcome by the welding process, which has been proved by years of manufacture to make not only a stronger joint than rivets or screw threads but a joint that can be depended on never to leak or come loose.

Illustrations on this page by Universal Oxygen Co., Sheboygan, Wis.

BUSINESS VERY BRISK.

Business in welding circles in the middle west is very brisk. Not only do the acetylene and oxygen people find it difficult to keep pace with orders, but manufacturers of apparatus and supplies as well are doing a big business.

Manufacturers of arc, spot, butt and resistance machines report a brisk trade, spot welders especially. In supply circles jobbers and dealers in rods and wire find it difficult to secure goods from the mills.

SPOT WELDERS FOR JOB WORK.

The manufacturer who is not able to keep his spot or but welders busy these days is overlooking an opportunity. In most of the larger cities job work is being solicited and high speed steel work is in demand. Elsewhere in this issue we are publishing an article relative to welding high-speed to carbon steel.

EVOLUTION OF A SUCCESSFUL WELDER

There have been in the past no guide posts on the road to an education in the trade of welding. It was every man for himself. Just how the early pioneers in the business gained their experience makes interesting reading for those who are also having their failures and their trying moments when new and unexpected contingencies arise.

Mr. Charles Hollup, a resident of Milwaukee, Wisconsin, for years superintendent of all the departments having to do with welding in the large Milwaukee shops of the Vilter Manufacturing Company, gives his experiences in welding for the benefit of readers of *The Welding Engineer*.

It should be said in reference to these experiences, that Mr. Hollup enjoyed rather unusual advantages in his study of welding. His employers gave him free rein in research work, not only providing him with materials for his experiments but allowing him also the time necessary to carry them out. His own recital of his experiences follows:

I started nine years ago, at which time there was very little known about oxy-acetylene welding in this country.

It was a very discouraging beginning and a test of patience and ability to overcome failures through inexperience in handling the work at hand.

Looking back at all the different experiments I have made, I have come to the conclusion that the majority of welders do not take enough interest in the work and study the different problems that come up so as to get the best results obtainable. The most failures in welding are due to the fact that too little thinking is done, as to how to get at the job, how to take care of the expansion and contraction of the metal, and how this expansion will affect the casting at hand.

It is a wrong idea to take anybody and give him a welding equipment and simply tell him to "go to it." If the man should not be interested in it, he will not be able to accomplish wonders, whereas when a man is picked that takes a liking to it, and he is allowed to experiment at first, in place of giving him a pile of castings to repair, and telling him, "We must have these quick," he will not be discouraged at the first and simply say the work can't be done.

Use of Different Methods.

As to the usefulness of welding, everyone knows now that there is no limit to it. In the same way as certain tools are best adapted for certain work, the different methods of welding have their field of usefulness.

Fortunately, we have use in our line of manufacture (pipe coils and tanks) for several methods of welding among which are the oxy-acetylene gas welding, oxy-hydrogen gas welding and cutting, electric resistance welding and electric arc welding with both metallic and carbon electrodes.

For welding aluminum, brass, light cast-iron sections, sheet metal work and certain small and nicely finished work, we prefer gas welding.

For heavy sections of cast-iron and steel, or large tanks welded at the seams, heads and outlets, we use the electric arc welding.

For butt-welding of pipes for pipe coils, the electric resistance welding is giving best satisfaction. In our plant the Thomson process is used.

It is not because some of these operations could not be done by any other process, but because the same are cheaper that we adopt the different methods. Certain classes of work that we used to do with gas, we are now doing electrically and save fully 30 per cent of the cost over the former method.

Tests for Strength of Welds

As far as strength is concerned we find very little differ-

Oxweld Apparatus For Railroad Service

is to broken equipment what a new point is to your pencil. Its use gets the other 95% value out of your equipment that has broken long before its mechanical life should have gone.

Reclaim the profits discarded in your scrap pile with our Oxweld outfit. A broken tooth on a gear is easily built up and refinished and the gear goes back to work for its full life, and so on throughout the whole list.

On your wrecking trains this outfit will prove of untold value. Tangled steel wreckage is quickly cut up; service is quickly resumed. The cost is tremendously reduced. The profit is the difference between scrap value and replacement cost, less the small cost of repairs.

Oxweld Railroad Service Company

Railway Exchange Building
Chicago

30 Church Street
New York

ence between gas welding and the electric arc if both are properly handled.

Tests that I have made with welded tanks, show that they compare very favorably with riveted tanks. In one tank made of 8-inch seamless drawn tube with ⅜-inch wall, we welded two 1¼-inch thick flat heads and tested it to 3,600 lbs. per square inch without a sign of leak or weakness in the weld. On another tank made of 8-inch common pipe, with 7-16-inch thick dished and flanged heads welded in so that the dishing of the heads was to the inside of the tank, or concave, we put on a pressure of 3,200 lbs., at which pressure both heads turned the dishing outward to conform to the ball shape and still the welds were in perfect condition. The pipe, itself, expanded half an inch in diameter.

These welds were made with the electric arc. One tank welded with oxy-acetylene was made of ⅜-inch flanged steel, rolled to 20 inches diameter. The longitudinal seam was welded and the 9-16-inch thick dished and flanged heads were welded in one concave and the other convex. At 1,200 lbs. pressure, the concave head started to bulge to the outside, but the welds were left in perfect condition.

These tests show that the welds were stronger than the material itself. In one test, carried to destruction, we took a lap welded steel pipe and welded both heads convex and at nearly 4,000 lbs. pressure the pipe burst open lengthwise, leaving the weld around the heads intact.

This goes to show that welding properly done is as safe as riveting with the advantage that no occasional calking has to be done to keep a tank tight.

In conclusion I will say that anybody interested in welding, can now get any information about how to do the work or which equipment would be most suitable for certain work. Welding has come to stay and it certainly has reduced the costs of manufacture in a thousand and one instances.

TRADE NEWS.

The Superior Oxy-Acetylene Machine Company, Hamilton, Ohio, have placed a new acetylene generator, together with gauzes and a welding torch in the market. The generator is all cast iron, making it indestructible from rust and has the latest motor feed.

The report of the Chief Inspector of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles has just been issued. The report is dated February, 1916.

At the recent display of railroad supplies held at the Coliseum there were several concerns interested in the welding field, among them being The Commercial Acetylene Railway Light and Signal Co., Willis C. Squires & Co., Springfield Switch & Frog Co., General Electric Co., and the Carbic Mfg. Company.

The Carbic Mfg. Company, of Duluth, has brought out a new acetylene generator and welding and cutting torch. A feature of the generator is the use of carbic cakes.

H. B. Pearson, vice president and general manager of the Searchlight Company, has resigned to go with a manufacturer of munitions in the East. His duties have been assumed by A. Paul Binnern, with the title of general sales manager.

The Bishop-Babcock-Becker Co., of Cleveland, has just issued a new catalog covering their oxy-acetylene welding and cutting apparatus. The catalog describes regulators,

Are You Looking for a Job?

During the past month The Welding Engineer has received a considerable number of requests to furnish experienced welders and salesmen. We can assume no responsibility in the matter, but are quite willing to act as a clearing house for the trade. Applications for employment or for help which are referred to us will be held in confidence.—Editor.

Jobs for Men

If you are an employer and are in need of a welder or a salesman, write us about it. We may be able to put you in touch with the very man for the job. Tell us what you expect in the way of experience and approximately what you will pay. Also state if electric, thermit or oxy-acetylene experience is required. Your communication will be held in confidence—there will be no publicity.—Editor.

Men for Jobs

The Welding Engineer is always willing to help competent men. If you seek a position, write us and state your experience and wages expected. Give full details about experience—don't be too brief. Be sure to state if your experience covers electric, thermit or oxy-acetylene work. If you are married, say so, and you might add your age. We will treat your letter in confidence and if we can put you in touch with a job it will be our pleasure.—Editor.

gauges, welding and cutting torches, decarbonizing devices, etc.

The International Oxygen Company, New York, has issued catalog No. 3 on "I. O. C. Bipolar Oxygen and Hydrogen Generators." This catalog will be of interest to users of oxygen and hydrogen.

The Macleod Company, Cincinnati, manufacturer of railroad and contractors' lighting outfits and other specialties, has leased a five-story building in West End, which will more than double its capacity.

The autogenous welding of National pipe is made the subject of a pamphlet of 50 pages issued by the National Tube Company, Pittsburgh, Pa., as its bulletin No. 26. The booklet contains generous extracts from a number of important papers on this subject as well as some independent contributions on various features of pipe joints welded by different processes. The bulletin is noteworthy for the large number of striking and informing illustrations and owing to the recent development in the art, the publication is timely.

Mr. A. S. Hall, of Springfield, Mass., recently read a paper before the 46th annual meeting of the New England Association of Gas Engineers. The title of the paper was "The High Pressure System and the Welding of High Pressure Mains at Springfield, Mass."

Mr. B. Kopfersmith, who is in charge of welding for the New York Central Lines at Jackson, Mich., recently made several small paper weights which show the skill of the practical welder. The weights are in the form of a flight of steps, the small strips making up the steps being steel, brass, cast iron, bronze, copper, aluminum and tin.

The Glens Falls Forging & Welding Company, Glens Falls, N. Y., has filed incorporation papers showing a capital stock of $75,000. It will operate a general foundry and manufacture motor vehicle parts, special hardware, etc. J. A. Curley, Glens Falls; C. Hibbard and J. H. Conley, Fort Edward, are the incorporators.

The Michigan Electric Welding Company, Detroit, has increased its capital stock from $25,000 to $100,000.

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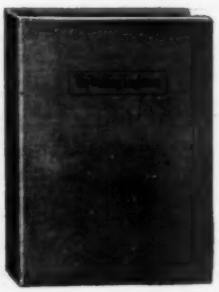

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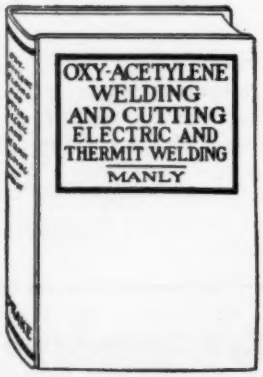
Oxy-Acetylene Welding and Cutting
Electric and Thermit Welding

By HAROLD P. MANLY

Chief Engineer American Bureau of Engineering



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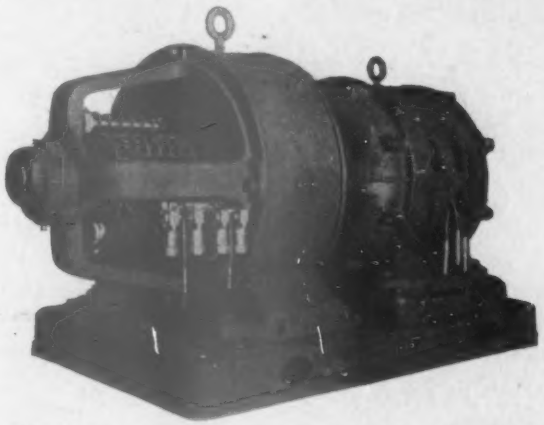

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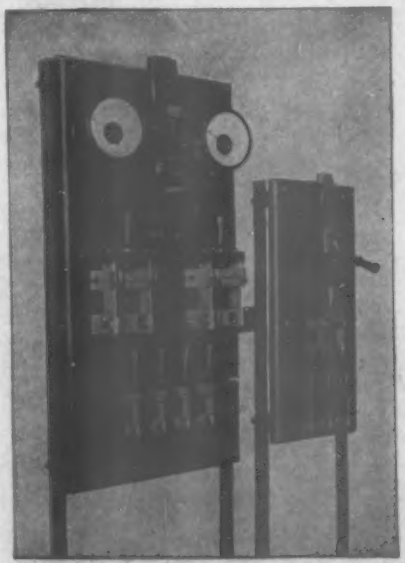

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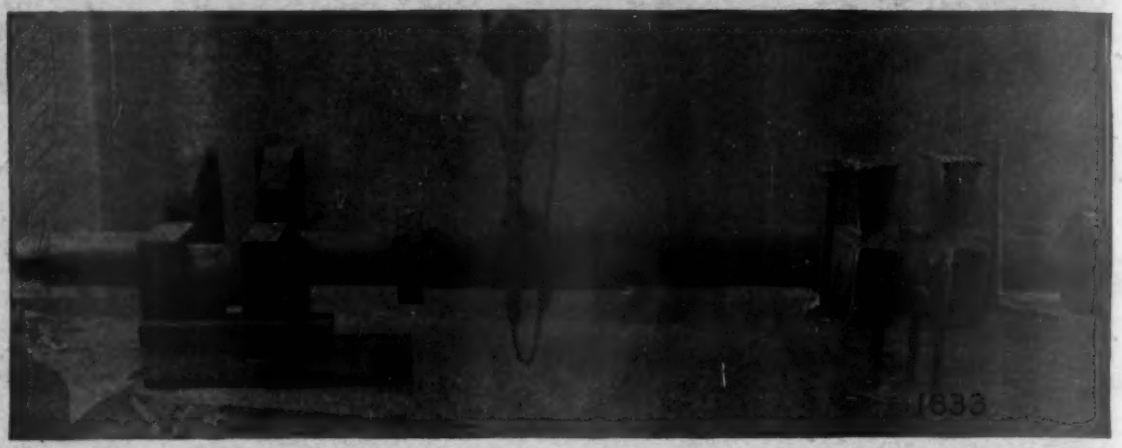

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